MACHINERY

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THE EXTRUSION OF SHELLS AND TUBES*—1

By CHESTER L. LUCAS†

Just because a diemaker miscalculated a little, leaving the face of a punch too long, there is a healthy, growing corporation doing business in a comparatively new field of metal goods manufacturing. This, in a nutshell, explains the existence of the Metallic Shell & Tube Co., of Pawtucket, R. I., although the whole story is somewhat longer.

In 1903, George W. Lee was located in Binghamton, N. Y., engaged in the manufacture of the familiar one-piece collar button shown at *A*, Fig. 4. After a short time it became apparent that the Connecticut Yankees, by means of just such machines as the multiple plunger press, described in the August, 1911, number of MACHINERY, were turning out collar buttons by the ton so cheaply that he could not compete with them. Naturally, he began to look around for some other similar product that he could manufacture with his equipment of presses, shears and tools, and he hit upon the idea of a fastener, part of which is shown at *B*, Fig. 4. He immediately patented this "bachelor's button," and commenced to manufacture it on a small scale.

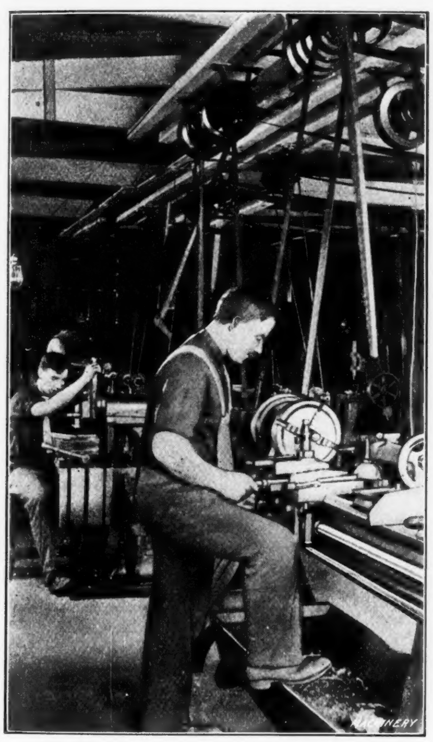

Fig. 1. Making Extrusion Dies

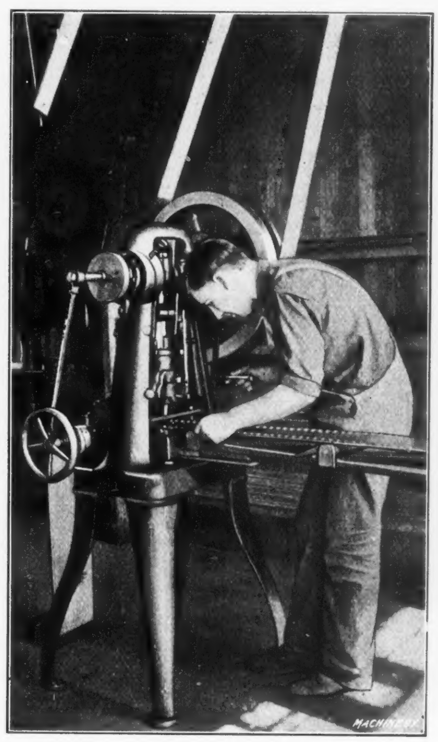

Fig. 2. Cutting and Drawing the Blanks

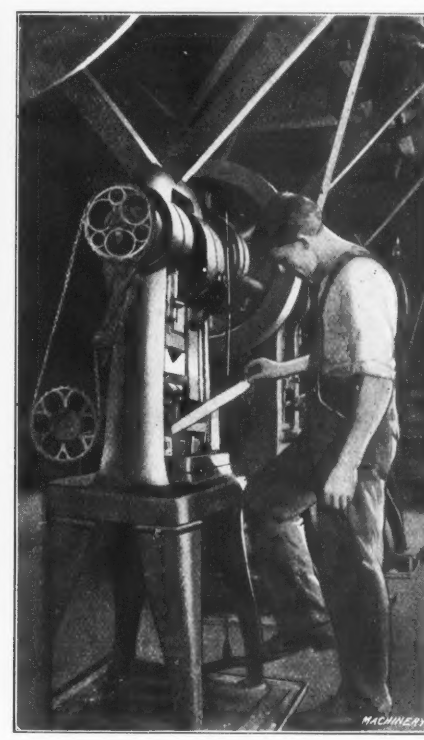

Fig. 3. Feeding the Blanks to the Extrusion Dies

After getting fairly well started, it occurred to him that if he made a slight change in his dies, so as to give the face of the button the appearance indicated at *C*, Fig. 4, the product would have a more finished appearance, without increasing the cost of manufacture. The dies for the button appeared about as shown at *A*, Fig. 5, in which the aluminum blanks, ½ inch in diameter, were placed and formed in the usual manner. To obtain the improved shape of the face of the button, he assumed that it would only be necessary to leave a small projection on the punch. He then made a punch with the projection left a little longer than he had intended, but he concluded to try it out. To his amazement, he found that instead of the slightly changed button that he had expected, he had a tube about ¾ inch long, with the flanged face of the button intact, as shown at *B*, Fig. 5. Lee pondered over the matter, tried more blanks in this die, with the same results, and decided that the explanation was that the metal, being confined on all sides except for the annular opening formed by the opening in the die and the projection of the punch, *had* to go through this space when pressure was applied.

With this principle in mind, he tried several other experiments along the same lines, and finally applied for patents on the process of extruding tubular metal bodies by means of dies of the type shown in Fig. 6. When the patent examiner at Washington read the specifications and saw the drawings, he was incredulous, and before allowing the patents, Lee was obliged to make several tubes for the examiner; after furnishing affidavits as to his work, the patents were allowed. During the next four years Lee worked incessantly on the process, but with little real success. He tried all kinds of steel, dies and presses, and at the end of that time he had spent about thirty thousand dollars, but still the process was not on a paying basis.

At this point Mr. Leslie E. Hooker and three other men bought the patent rights of Lee and organized a company to make a commercial success of the extrusion process. Mr. Hooker proved to be a man who "did things." He had been watching the experimental work for some time, and he had ideas of his own with relation to it. He took out several patents on improvements, and started a factory in Pawtucket, R. I., where at present the extrusion process is being worked successfully. The company is making tubes and shells in large quantities, and as manufacturers and designers are becoming more and more aware of the value of extruded work, the prospects seem unusually bright for the future.

General Outline of the Process

Since George W. Lee stumbled over the extrusion process in 1903, many changes have been made in the details of the methods, but in general the principles are the same. Briefly stated, the extrusion of tubular bodies is accomplished by confining a metal blank within a strong cylindrical chamber whose only outlet is through an annular opening at the bottom, formed by the projection on the punch and the hole in

* For information on the extrusion process, previously published in MACHINERY, see "The Extrusion Process," October, 1911, engineering edition.
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the bottom of the die. The size of this opening may be made of any required dimension, so that tubes and shells of different measurements can be made.

Figs. 7 and 8 illustrate the features of dies for extruding tubular shapes. The containing ring is shown at *A*, the lower die at *B*, and the punch at *C*; part *D* is the former. In Figs. 6 to 9 inclusive, the die rings, dies and punches only are shown, for they are the vital parts of the apparatus. In Figs. 7 and 8, the blanks are shown at *F*, just after the extruding operation has started.

Fig. 7 shows a plain flat blank being extruded, but as the process was developed it was found better in every way to use a cup-shaped blank like that shown in Fig. 8. This shape of blank takes no longer to make than the flat blank, if cut and drawn in one operation. The chief advantage in using the cup-shaped blank lies in the fact that the metal extrudes more easily, for the work is distributed over a longer space. This fact is more readily apparent by noting the differences

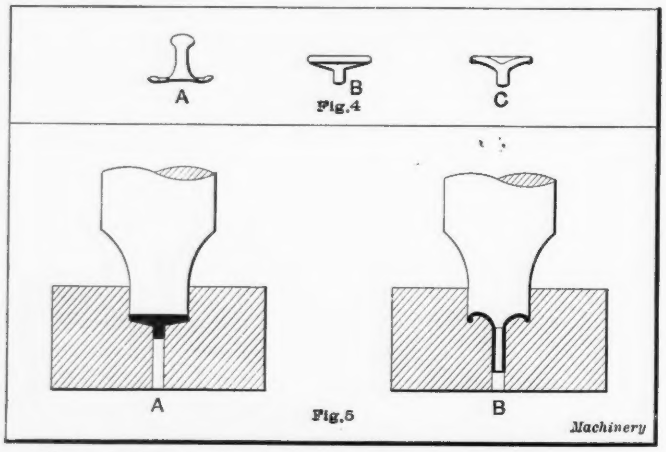


Fig. 4. A, Collar Button; B, Fastener; C, Improved Fastener. Fig. 5. A, Die for Fastener, with Work in Place; B, Die intended to produce a Fastener of Improved Design, showing Piece actually produced

in the distances traveled by the punches in Figs. 7 and 8. There is, however, a limit to the proportions of this cup, for if made too deep and narrow, the punch will be too weak to stand the strain; if made too shallow, on the other hand, the object of cupping will be defeated. In general, the walls of the cup should be from 3/32 to 1/8 inch; from 3/8 to ½ inch is a proper depth for the cup. In some instances, as in cartridge case making, it is desirable to have the bottom of the tube as thick as possible, in which case the cup is made without reducing the thickness of the bottom. In nearly every tube, however, it is advantageous to have the bottom of the finished tube of the same thickness as the walls of the tube; therefore, after cupping, the bottom is thinned down by stamping, and the top edge of the cup is chamfered toward the inside at the same operation.

Suppose a shell is wanted with tapering walls, thickest near the bottom, as in the cartridge work illustrated at *P*, *Q*, *R*,

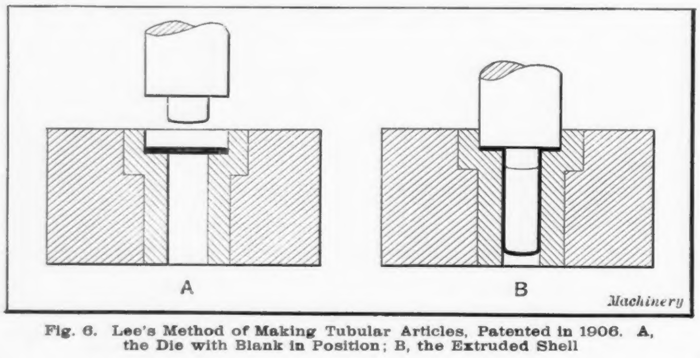


Fig. 6. Lee's Method of Making Tubular Articles, Patented in 1906. A, the Die with Blank in Position; B, the Extruded Shell

and *S* in Fig. 11. To produce this effect, as indicated at *K*, the former is made with its sides sharply tapered towards the point, as shown in Fig. 9. Then, when the former enters the die opening, the space around the former is quite large, and the walls of the tube at this point will be correspondingly thick, as shown at *A*. At the end of the stroke, illustrated at *B*, the space around the former is very narrow, because the thick part of the former has entered the hole in the die through which the tube is being extruded. At this point, then, the walls of the tube will be very thin. To be a little more specific, let us assume that we wish to make a shell or tube, six inches in length, the walls of which are to be 1/16 inch thick at the base and 1/64 inch thick at the top. The former is 3/8 inch in diameter at its widest point. As there is a difference of 3/64 inch in the thickness of the walls of the

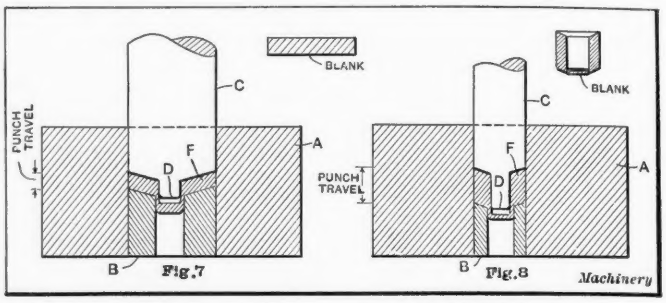


Fig. 7. Extruding from a Flat Blank

Fig. 8. Extruding from a Cup-shaped Blank

tube, there must be twice this amount of difference in the diameters of the former at its end and base. Therefore, the former for this tube must measure 9/32 inch at the end, to produce the tube shown in Fig. 9.

Some idea of the speed at which the tubes are extruded from the dies may be obtained by observing the fact that in extruding an 18-inch tube, the punch moves but ½ inch. As most extruding is done without using geared presses, the tube metal moves the 18 inches in a very small fraction of a second, generating a good deal of heat while doing so. The operators of

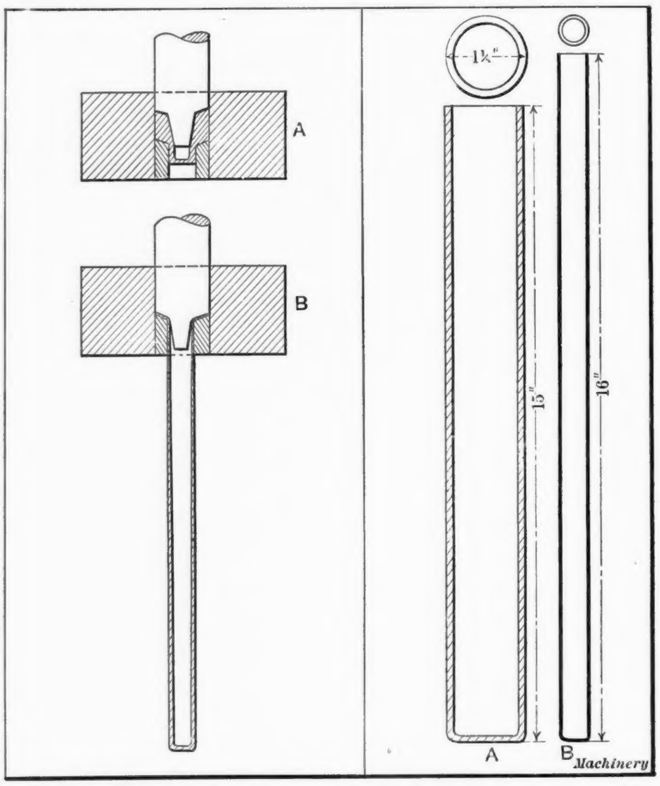


Fig. 9. Making Tubes with Taper Walls

Fig. 10. Comparison of Tube-making Methods

the presses are very careful to keep out of the way of the tubes that are being extruded. Fig. 3 shows one of the smaller extruding presses with the operator feeding the cup-shaped blanks down the slide to the dies.

Presses for Extruding

Nearly all types of presses or extrusion machines, as they are commonly called, have been tried—power presses, drop presses, screw presses and even steam hammers. Hydraulic presses have not yet been used to any extent on tubular work, because large sized work has not yet been attempted. Drop presses are not satisfactory on account of the shock of the blow and the consequent shortening of the lives of the dies. The wear and tear on the dies is great, even under the most favorable conditions, so that it is important that everything possible should be done to lighten their work. Screw presses

are very powerful, and the shock of the blow is not excessive, but it is difficult to strike exactly the same blow each time, especially with the German type of press using the friction drive; therefore, their use has been given up. Steam hammers, of course, are out of the question for several very apparent reasons.

So far, the most satisfactory style of press seems to be the crank press, of the geared or plain type. There is the danger of springing the shaft, but on the whole this type seems to be as efficient as any. Ferracute presses are used for extruding, and so are Bliss presses. Small tubes may be extruded on Bliss No. 52 presses, and for heavier work the No. 37 Bliss

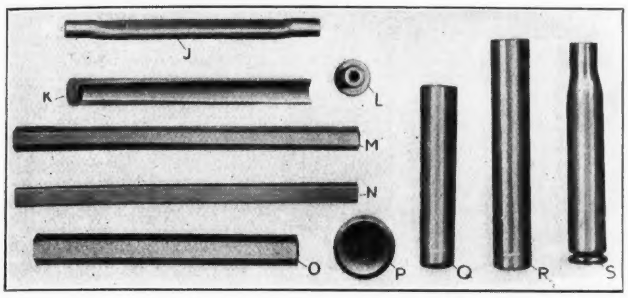


Fig. 11. Miscellaneous Examples of Extruded Work

press of the geared type is very satisfactory. These presses have strokes of 1½ inch, which seems to meet all requirements.

One of the best presses in use at the Metallic Shell & Tube Co. is a powerful Bliss press that was originally made for a counterfeiter who was getting ready to literally "make money." Through the aid of the manufacturers of the press, the E. W. Bliss Co., of Brooklyn, N. Y., the secret service men put the "money-maker" into the federal prison. The press was sent to the St. Louis Exposition, where it was used in making souvenir medals. Fig. 12 shows this press as it appeared at the exposition, fitted with an automatic feed; with the exception of this feed, the press was purchased by the Metallic Shell & Tube Co., and is in use to-day. From the illustration it will be noted that the press is an ideal one for heavy work on account of its rigid frame and heavy bearings.

Metals Used in Tubular Extrusion

It is almost needless to say that the softer the metal is, the easier it may be extruded. Naturally, then, lead is the easiest metal to extrude, and it is used to a great extent in alloys that contain small percentages of other metals, for making collapsible tubes and similar goods. Pure tin is still more used for the better grade of collapsible tubes. This phase of the extrusion process will be described in a coming number of MACHINERY.

Aluminum comes next in order, and in fact, there is no better metal to extrude, if aluminum will meet the requirements of the work for which the shell is to be used. There is one slight disadvantage in working aluminum—it is impossible to cut and draw thick stock into the proper kind of cup to use as a blank for extruding, which means that another operation will be required. A particularly valuable alloy is one that contains 98 per cent aluminum and 2 per cent zinc. Not only is this a strong alloy, but it can be extruded easily. The best lubricant known in the press-working of aluminum is soapy water.

Pure zinc is a soft metal, but contrary to the general rule, is a poor metal to work in this process. It can be extruded easily enough, for it flows very nicely, but its effect on the former and die is to roughen them in a very short time, and after several hours' work the dies will be unfit for use. Minute particles seem to separate from the zinc and are forced into the surfaces of the dies.

Copper is a very satisfactory metal to extrude. Some of the best examples of extrusion have been produced from copper. The better the grade of the metal, the better it will extrude, although ordinary commercial copper works very well. Lard oil is used as a lubricant. The better mixtures of brass can be extruded fairly well, although not as well as copper. For this reason a metal consisting of 70 per cent copper and 30 per cent zinc is a better metal for this purpose than the "two-and-one" mixture for brass. In short, the more copper in the brass, the better.

Gilding metal, containing mostly copper in its composition, is a good metal to extrude. This metal is used largely by the jewelry trade as a base upon which to gold-plate; hence its name. Pure gold will work well in the extrusion process, but 14-carat gold cannot be extruded at all; it is too tough. The reason for this is not very clear, as copper is used in the 14-carat gold alloy; but the fact remains that gold and the copper, two soft metals in themselves, make a very tough alloy. So far, it has been found impossible to extrude iron or steel, as the dies give out under the extreme pressure required.

The effect of extrusion upon the structure of the metal being worked is beneficial, in that the grain of the metal is toughened and made much stronger. To start with, the metal is soft. After the blanking and cupping process, which operation is shown in Fig. 2, the cups are annealed. When the tubes come through the dies they are as tough and springy as could be desired, and still they are not brittle.

When extruding thin tubes, especially of the softer metals, holes are punched through the bottoms of the cups to let the air into the tubes while they are being extruded; otherwise the air pressure from without would cause a tube with thin walls to collapse, because the interior would be almost a perfect vacuum. Of course, if the bottom of the tube must be kept intact, this method cannot be adopted. The effect of the air pressure is well illustrated by the flattened tube shown at *W*, Fig. 14.

A Modern Extrusion Die

Fig. 15 represents a modern style of die for extruding tubular metal shapes. As will be noticed, the principles are the

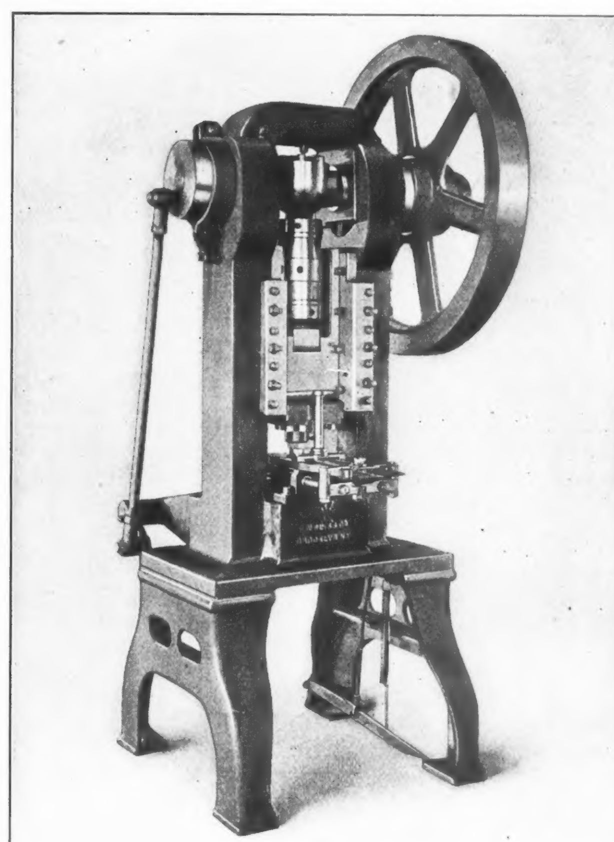


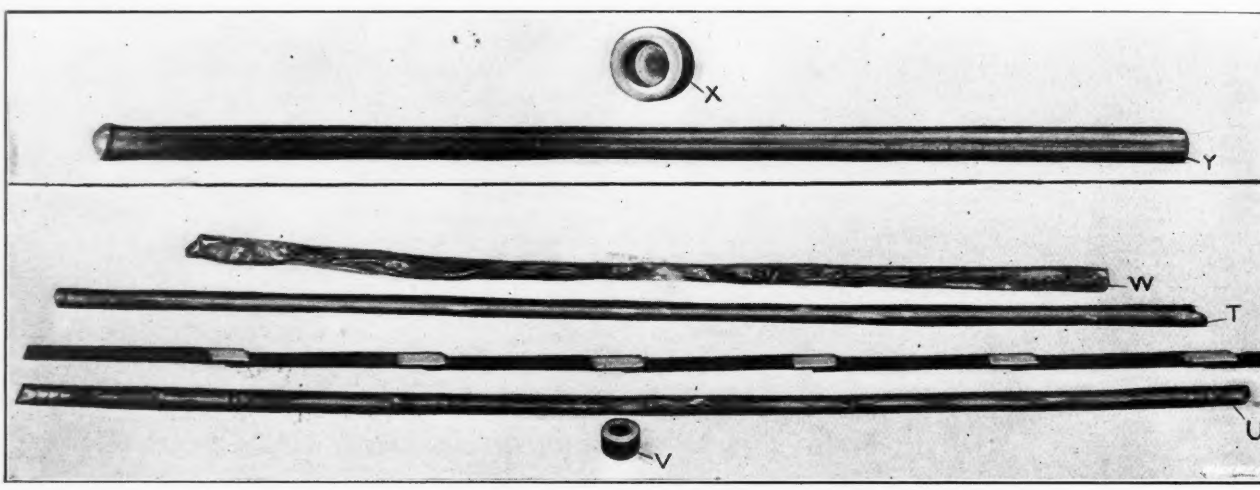
Fig. 12. Bliss Press, made for Coining, but now used for Extruding

same as in the original Lee dies, although several details have been changed and a few features added. In this illustration, *A* represents the bed of the press; *B* is a bolster in which the hardened steel bushing *C* is a very hard driving fit. Bolted to the bolster is the die shoe *E* which is shrunk around the die ring *D*. By shrinking the die shoe around the die ring, a very tight fit is assured. Another important reason is that the temper of the high-speed steel die ring can, by being mounted in this way, be drawn just enough to leave the die tough, enabling it to stand the strains incident to its use. The die ring is ground out after hardening and a bushing *F*

is fitted. This bushing is a very important part of the die, for in the old-style dies, when the interior of the die gave out, a new die ring was required. If a bushing now breaks, it merely means that a new one is to be slipped in, without even taking the die from the press. These bushings may be made several at a time and kept in readiness for an emergency. It is very essential that the inclined face of this bushing be polished very smooth, and that the edge of the hole be slightly rounded, so as to help the metal to form itself into the shape of the tube. The size of the hole in this bushing governs the size of the tube, and it must be ground to size and lapped to a smooth finish.

The Punch and Former

Second in importance only to the die, is the punch and former. It is the function of these parts of the tools to force the metal to flow to the hole in the die and to form the inside of the tube or shell being extruded. The punch *G* is really a removable tip to the punch body *I*, being held to it by the taper sleeve or nut *H*. The reason for having the punch in two parts is to make it easier to replace in case of breakage—there are plenty of breakages in extrusion tools. The end of the punch is turned off on a bevel to agree with the face of



Figs. 13 and 14. Lead Tubes for Torpedo Work. Examples of Difficult Extrusion

the die, and this surface must be just as highly polished as that of the die. The outside of the punch must be a close sliding fit in the die ring, for if it is loose there will be danger of its breaking.

The former *L* sizes the inside of the tube, and as the metal is constantly slipping past its end, the former *L* is polished

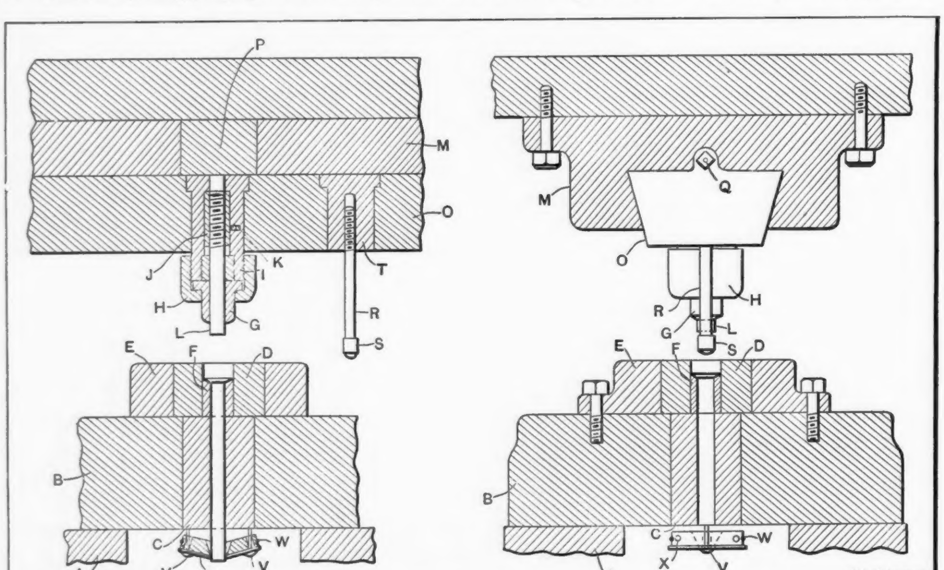


Fig. 15. A Modern Die for Extruding Tubular Shapes

very highly, as is also the inclined face of the punch itself. An important feature of the former is its independent movement with relation to the punch. The internal end of the former is threaded into the bushing *J* which is free to slide within the punch body *I*, but is prevented from turning by the screw *K*, engaging a groove in the bushing. When the cup-shaped blank is struck by the punch, former *L* is pushed back to the position shown in Fig. 15. As the metal flows inward, a tremendous pressure is brought to bear on the former in a downward direction, and on the punch in an upward direction. This pressure often breaks the solidly

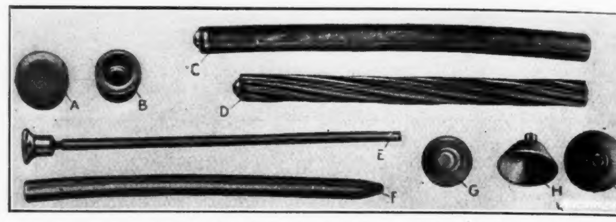


Fig. 16. A, B, C, and D, Steps in Making an Instrument Case by Extrusion; E and F, Extruded Parts for Automatic Pencils; G, Bullet Jacket; H and I, Hat-pin Guards

combined punches and formers. In this die, the pressure carries the former and its sliding bushing down into the tube, and by the time the limit of the movement is reached, the extrusion process has had a fair chance to start, and the pressure is consequently diminished.

The Slide and the Stripping Punch

After each extruding operation there is a thin washer-like piece of scrap left in the dies and attached to the tube, for it is impossible to extrude every particle of the metal. The means taken to clear the die of this scrap are interesting. The body of the punch *I* is driven into a slide *O*, which works in the head-block *M*. This block is, in turn, bolted to the ram of the press. The travel of slide *O* is limited by two stops, one of which is shown at *Q*. Into the head-block is driven a block of hardened steel *P*, directly in line with the dies below. When slide *O* is at one end of its travel, the punch is backed up by this block. At the other extreme of the travel of the slide, stripping punch-base *T* comes in line with the die and consequently is also, in its turn, backed up by block *P*. A threaded hole in base *T* receives the stripping punch *R* which at its lower end has a bushing *S*, the diameter of which is midway between that of the hole in the die and that of the inside of the tube. After the tube has been extruded, the slide is moved to its other position, bringing the stripping punch *R* in line with the die. At the next stroke of the press, the stripping punch enters the die, the front end of the bushing severs the tube from the scrap, and on the return, the top edge of the bushing catches the scrap and pulls it out of the die. The slide is then moved back to its original position, and at the next

stroke of the press another tube is extruded. Thus it will be seen that every second stroke produces a tube or shell, while the intervening stroke removes the scrap from the die. After the stripping punch becomes filled with these scrap washers, it is unscrewed from the base and cleared of the scrap.

Another improvement on this extruding die is the device beneath the die for preventing the tubes from being pulled up into the die when the stripping punch ascends. This device consists essentially of two semicircular leaves *U*, held together by a spring *W*. These leaves, or gripping jaws, are supported by two pins *V* which allow the jaws to tip slightly downward when pushed from above. Therefore the tubes are permitted to pass downward through the jaws, but the jaws resist any upward pull by gripping the tube and effectually holding it.

After the tubes have been extruded, their forms may be changed by making them square or hexagonal, or they may be straight or spirally fluted. These operations are done by running them through dies, properly shaped, with punches of the same shapes to support the interiors. Round tubes that must be very straight and true are sometimes run through round dies to correct errors. At *M*, *N*, and *O*, Fig. 11, are illustrated tubes of hexagonal and square sections.

Some Examples of Extruded Work

Perhaps the most impressive pieces of tubular extrusion done at the Metallic Shell & Tube Co. factory, are the lead tubes shown at *T* and *U*, Fig. 14. This work really does not require as much skill to produce as the majority of the extruded shapes, but it shows up well. These tubes, which are 36 inches long, are used as containers for the explosive for torpedoes. They are cut to short lengths, and the ends folded over. The blank, after being cupped, appears in front of the tubes. Lead is so easy to extrude that care was not even taken to chamfer the top face of the blank.

A Difficult Piece of Work

For really difficult work in this line, the copper tube *Y* in Fig. 13 is a fine example. It is but 3/8 inch in diameter and is 16 inches long. The walls are less than 0.010 inch thick. Fig. 10 is shown for a comparison of the two methods of making sheet-metal shells with closed ends; *A* represents the shell for a bicycle pump and is about as deep and narrow a shell as can be successfully drawn. To make this shell from copper or brass would require at least twelve operations. Contrasted with this piece of work is the copper tube at *B* which was made in three operations. In fact, it would be impractical to use more than three operations for extruding this tube. It would be impossible to duplicate this tube by ordinary press drawing operations.

Instrument Cases

A very pretty illustration of an extruded product is shown in the aluminum instrument case illustrated at *D* in Fig. 16, together with the successive steps in its making. The first operation consists in blanking the disk *A*. The next operation is to cup this blank by punching the center into a die that also forms the ornamental bead on the end of the tube. Then the blank is extruded to make the tube *C* itself. Finally the tube is trimmed to length and run through the fluting die, which completes the tube, straightening it as well. The fluting die is merely a thin die having spiral grooves in it. The punch, or mandrel, is free to turn as it pushes the tube through the die.

Automatic Pencil Parts

The two parts of an automatic pencil, shown at *E* and *F*, Fig. 16, represent some neat specimens of the extrusion process. The core of the pencil shown at *E*, which has a small hole running through the tube section, was first extruded with the hole clear through the head. Afterwards the piece was put in another die and the head flanged, closing in the end of the hole at the same time. The larger tube *F* was extruded in the usual manner, and the end closed in by another operation.

Bullet Jackets—Hat-pin Guards

At *G*, Fig. 16, is shown a small aluminum bullet jacket which shows the flange of scrap that is left by the dies. In this case, however, the flange is a necessary part of the bullet jacket.

The hat-pin guard, shown at *H* and *I*, is a somewhat unusual piece of extrusion work. The former is made just the size of the hole; the punch is chamfered off to fit the inside of the bell and the die is of the same shape as the under part of the guard. In this case, as with the bullet jacket, there is no scrap and the pieces must be taken from the die either by hand or by an ejector.

Miscellaneous Extruded Work

At *J*, Fig. 11, is shown an electrician's wire coupling used in splicing breaks in a wire. This piece is extruded as a plain round copper tube, and then slightly flattened in the center by a simple press operation. The small bushing at *L* shows that thick walls may be extruded as well as thin ones. At *P*, *Q* and *R* are shown three stages in making a brass cartridge case, as already mentioned. At *S* the end of the shell has been reduced by closing in a press, and the groove has been turned at the base of the cartridge. Cartridge making by the extrusion process will be dealt with more fully in a later article.

* * *

COST AND SIZE OF PANAMA CANAL

The work on the Panama canal is rapidly progressing, and although its cost is now known to be higher than was at first expected, it can hardly be said to be excessive, considering that it opens up an entirely new route which will ultimately affect the shipping conditions of the whole world. The cost of the canal is $350,000,000. It is interesting to compare this expenditure with the capitalization of some of the transcontinental railroads, which are roughly as follows:

Atchison	$580,000,000
Southern Pacific	750,000,000
Northern Pacific	550,000,000
Great Northern	350,000,000
Union Pacific	625,000,000

Hence, it will be seen that the cost of the new canal is only one-eighth of the total capitalization of these roads. It should be remembered, however, that the capitalization of these roads by no means indicates their cost. The capitalization is very much higher than the actual cost, due to the manipulation of railroad stock and bonds by financiers. The comparison is, therefore, not a very accurate one.

The total length of the canal from deep water from the Atlantic side to deep water in the Pacific is practically fifty miles, fifteen miles of which are at sea level. The width of the canal on the level sections and also between the locks, except for the section through the continental divide, is 500 feet at the bottom. The depth on the level portion is 41 feet at mean tide, and the depth of the channel between the locks is 45 feet. Through the lakes traversed, the width of the channel at bottom is not less than 1000 feet for 16 miles, 800 feet for another 4 miles, and 500 feet for about 3 miles. Through the transcontinental divide, a distance of about nine miles, the bottom width of the canal is 300 feet.

* * *

It is a common practice to produce a matt surface on sheet aluminum by dipping in a hot caustic alkali, but instead of a dead-matt surface, one of a mottled appearance often results. A satisfactory solution for producing a matt surface on aluminum is as follows:

Water	1 gallon
Caustic potash of soda	1 pound

This solution is used warm or hot and the aluminum is dipped into it. Hydrogen gas is immediately given off from the surface, and the latter gradually becomes black from the iron left undissolved. After this action has taken place for some time, the aluminum is removed, rinsed in water, and then dipped in the following solution:

Water	1 gallon
Nitric acid	1 gallon

The aluminum is then rinsed in clean water and dried. If the operation is conducted properly, the surface will have a dead and uniform appearance.

The mottled appearance is produced on the surface of the aluminum by not leaving it in the potash or soda solution sufficiently long. The alkali begins to "bite" immediately, and the operator is usually afraid that the surface will be too strongly attacked. However, this is not the case, and the solution should be allowed to act for some time. From three to five minutes is generally required for producing a good matt surface.—*The Brass World.*

DRAWING ROUNDING COVERS IN ONE OPERATION

By M. M.

The accompanying illustrations show a punch and die for drawing rounding covers to the full depth in one operation, without leaving a wrinkle, finishing them four at a time. As is well known, it is a difficult proposition to draw a shell to the shape shown; such a cover cannot be drawn in one operation by the standard double-action method, for the stock would

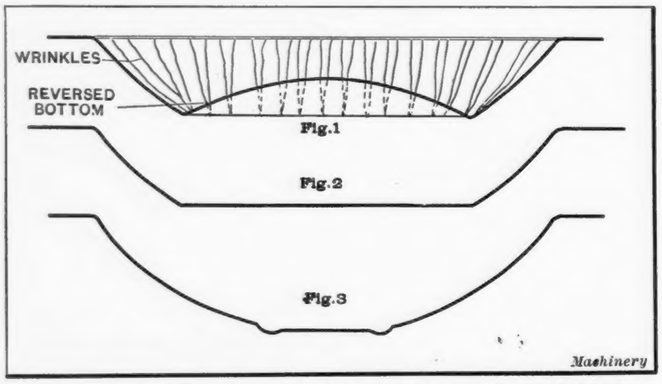


Fig. 1. Cover produced by Old Method of Drawing in One Operation, causing Wrinkles, even with Reversed Bottom. Fig 2. First Stage in Drawing Cover in One Operation. Fig. 3. Finished Cover

wrinkle and tear, making it necessary to spin out the wrinkles, as the punching would not stamp them out. An additional operation is required to finally stamp them all uniformly.

Fig. 1 is a view of the old-style method of making this cover which shows how the bottom has been reversed to stretch the metal and give enough stock for the crown and sides, the latter being very much wrinkled and sometimes "lapping." Considering the fact that these covers are of large size, ranging from 15 to 22 inches in diameter at the edge of the rounding top, and that each time the blanks

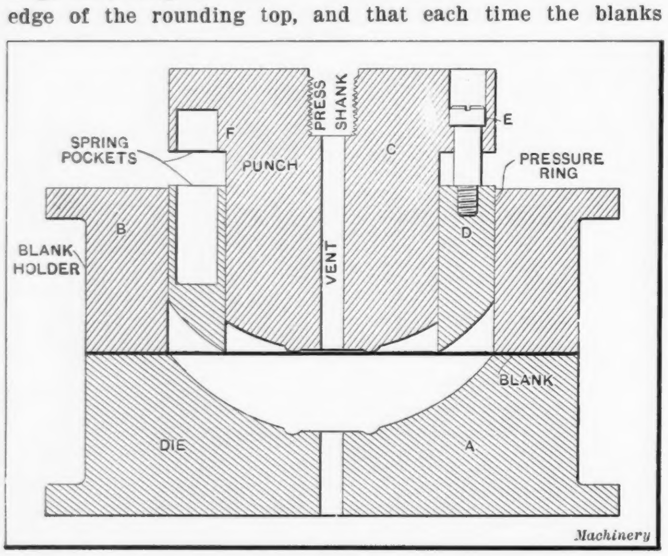


Fig. 4. Cover Blank Gripped by Blank-holder preparatory to the Drawing Operation

"lapped" it meant a loss of four, this proved to be a costly method. When they did come through all right, not only did the wrinkles have to be rolled out, but the blanks had to be stamped besides to bead them and reverse the shell.

To overcome these drawbacks and to eliminate the numerous handlings, the writer designed a triple-acting die for use in a double-action press. This made the complete shell, four at a time, in one operation to the shape indicated in Fig. 3. Fig. 4 is an assembled view of the die, showing all its parts. A blank is shown in position for drawing, being held by the blank-holder and die in regular double-action fashion, with the punch just touching. The die *A* is an ordinary double-action drawing die, made of cast iron, formed to the exact shape of the finished rounding cover, with a vent hole through the center of the bottom through which the ejector works. The drawing faces of both the die and the blank-holder are the exact size of the blank; the blank-holder *B* is of the regulation double-action type, made of cast iron, with an opening through the center to allow the drawing punch to slide through easily. Both the die and the blank-holder are secured to the press by means of a clamping flange. The punch *C*, it will be noted, contains the special feature that made the drawing of the finished shell a possibility. The punch, itself, is made of cast iron and is tapped at its base and thereby secured to the shank of the press. The outside diameter of the punch is just large enough to slide through the blank-holder easily. A shoulder is turned around the body of the punch over which there is a sliding pressure ring *D*, held in position by several shoulder screws *E*, between which are spring pockets containing heavy spiral springs of sufficient strength to draw the shell to the shape indicated in Fig. 2; the punch has corresponding spring pockets. When making the punch, this ring *D* was held back against the shoulder of the punch *C* and both faces were machined while in this position to give the internal form of the rounding cover. The normal position and appearance of the punch and ring are shown in Fig. 4.

The action of the punch and die in drawing the shells is as follows: After the blanks have been placed in position on the top face of the drawing die *A*, the blank-holder *B* attached

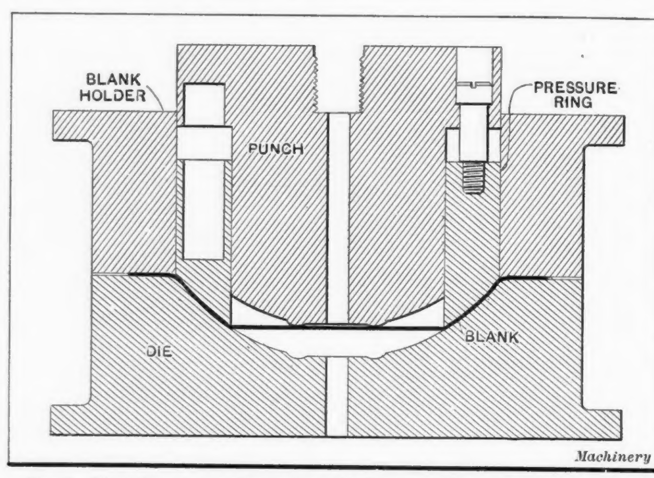


Fig. 5. First Step in the Operation, the Pressure Ring drawing the Blank to the Form shown in Fig. 2

to the pressure part of the double-action press, descends until it holds the blanks firmly against the die face. The punch pressure ring *D* then comes down, the heavy springs in the pockets being sufficiently strong to perform the first drawing operation which brings the blank to the shape shown in Fig. 2; Fig. 5 shows the punch and die after this operation, when the pressure ring has bottomed in the die, acting as an inner blank-holder while the punch descends still further to

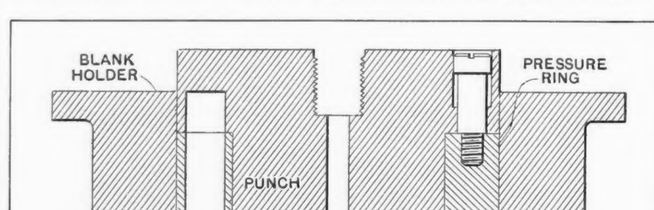


Fig 6. Final Step in the Operation, the Punch descending within the Pressure Ring to form the Bottom, leaving Blank as shown in Fig. 3

form the central part of the blank. The cover finally assumes the shape indicated in Fig. 3, the relative positions of the members of the punch being shown by Fig. 6. Altogether, the action was perfect and no defective shells were produced, the drawing being easy and uniform.

* * *

A reputation for furnishing something good is much better than a reputation for furnishing something cheap.—*Exchange.*

METHODS USED IN MANUFACTURING THE STEPTOE SHAPER*

By G. K. ATKINSON†

In the June, 1911, number of MACHINERY, several tools and methods used in the manufacture of the shapers built by the John Steptoe Shaper Co., Cincinnati, O., were illustrated and described. In the following article a few more of these tools and methods which are of interest to mechanics in general, will be described.

In Fig. 1 is shown a shaper converted into a surface grinder by removing the clapper box and mounting a heavy slab of cast iron in its place, to which latter an electrical grinder is securely bolted as indicated in the engraving. In the illustration, a vise jaw is shown on the shaper table, the sides being ground parallel. The jaw A is held down by the toe-clamps B, as indicated, while the top surface is being finished. It is then turned over and the other side is ground. This arrangement provides a very simple substitute for a surface grinder.

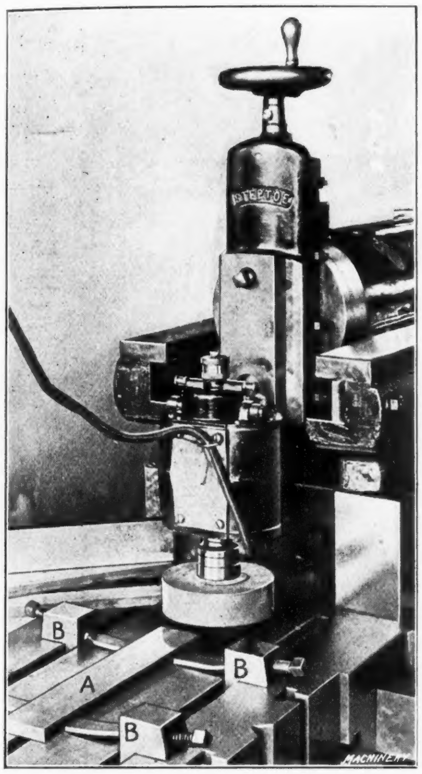


Fig. 1. Shaper converted into a Surface Grinder

In Fig. 2 is shown a keyseating attachment used on the shaper. The cutter bar A is hinged at B and supported in a guide bushing which is mounted on a pivot bearing in the back of the upright C as shown in Fig. 3. On the return stroke, the friction of the bar in bushing N causes the clapper block in the tool-head of the shaper to rise, the pivot bearings at N permit the bar to swivel, and the hinge at B gives it the required freedom to adjust itself. By this arrangement cutter E is automatically relieved from the cut on the return stroke. The cutter bar A is jointed at D and provided with a squared

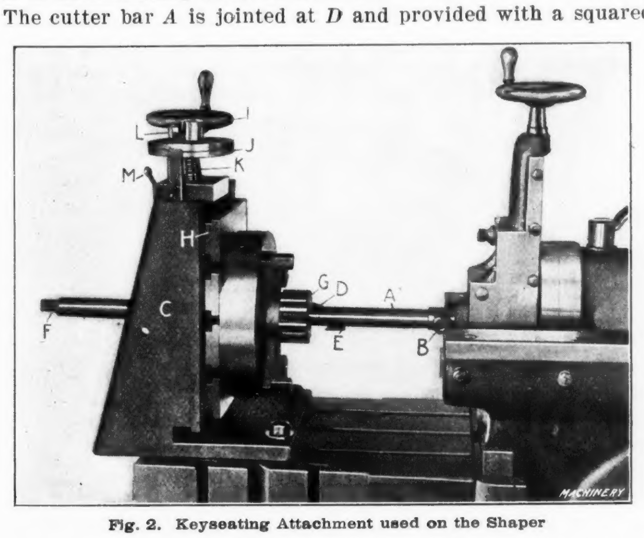


Fig. 2. Keyseating Attachment used on the Shaper

end at F for a wrench. On account of being jointed, the cutter bar can be disconnected when chucking or removing the work. The slide H is provided with T-slots for holding work which is too large for the chuck. This slide is actuated by the handwheel I. The large index collar J is graduated to read to 0.001 inch, and is adjustably mounted on the stop-screw K.

When the device is in use the fixture is bolted to the shaper table as shown, and the cutter bar is placed in a horizontal position by moving the tool-slide on the ram as required. The bar is then disconnected at D and the work is chucked

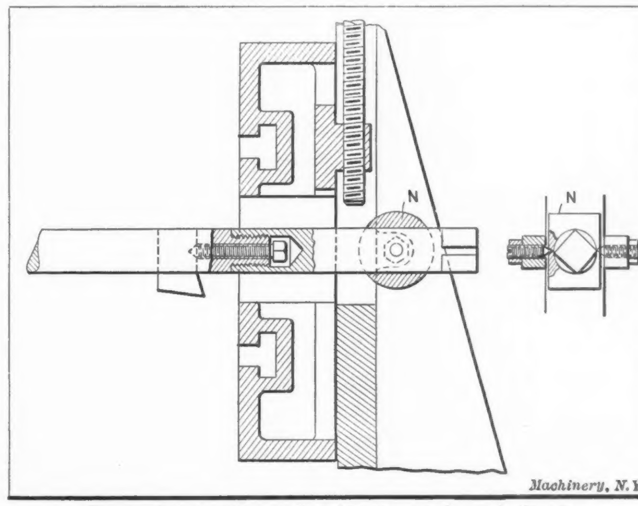


Fig. 3. Detail of Keyseating Attachment shown in Fig. 2

as shown at G. The cutter bar is then again connected and the ram is run forward until the cutter E is just inside the hole. Then slide H is raised by turning the handwheel I until the cutter comes in contact with the hole. Stop-screw K is then run down until it comes in contact with the slide H, and the index collar J is set at zero. Then the stop-screw K is moved up as many thousandths as required for the depth of the keyways, and is fastened by the clamp M. The work is then fed towards the cutter by the handwheel I until the slide H comes in contact with the end of the stop-screw which determines the depth of the keyway.

The taper arbors and expanding bushings shown in Fig. 4 are used when turning the bull-wheel bushings. In the illustration, A is a cast-iron sleeve which, after being fitted to the lathe spindle, is bored to accurately fit the end C of the taper arbor shown. The arbor has a keyway at C which engages a key in the sleeve. Bushings D are bored one-inch taper per foot to conform to the taper of the arbor, and are then put onto the arbor and turned the proper size to accommodate the different sizes of bull-wheel bushings. After this, they are drilled and split as shown. The end C of the arbor is drilled and tapped for a depth of 3/4 inch for the draw-in bar E, which latter is provided with a handwheel G for operating it, and a bushing for centering it in the back end of the lathe spindle.

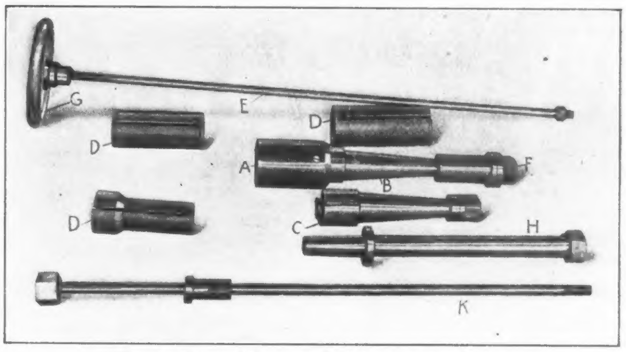


Fig. 4. Taper Arbors and Expansion Bushings

When this arbor is in use, one of the bushings D is placed on the arbor B and a bull-wheel bushing is placed in position on D, and clamped by tightening nut F. It is then drawn up snug against the sleeve A by turning the handwheel G, the outer end F being supported by the tailstock center. After the work has been turned, nut F is loosened and arbor B is drawn into sleeve A by the handwheel, thus releasing the work very readily. This arrangement provides for a rigid expanding arbor and one which can be quickly operated.

Gear blanks are first faced on the sides, using a tool-holder with two tools, one on each side. After the blanks are faced

*See MACHINERY, June, 1911: "Methods Used in Manufacturing the Steptoe Shaper."

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in this manner, they are turned to their proper diameter by placing them on the gang mandrel shown at *H* in Fig 4. These mandrels are fitted to the lathe spindle and are held in position by the draw-in bar *K*, being supported at the outer end by the tailstock center the same as arbor *B*.

In Fig. 5 are shown two planer tools *A* which are used for various conditions similar to that indicated in the halftone. The shanks of the tools are made of machine steel and the

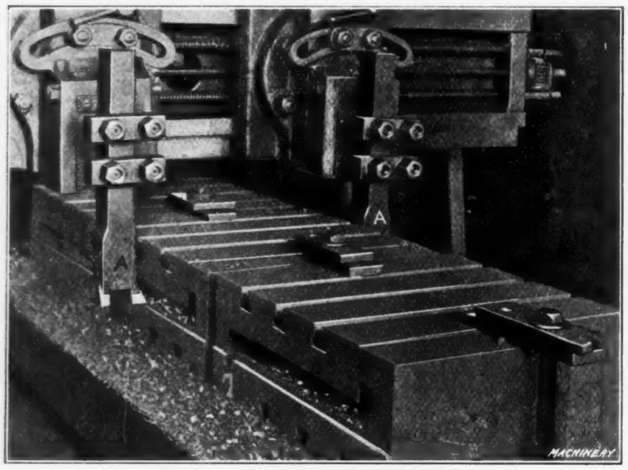


Fig. 5. A Planer Tool for Heavy Duty

cutters of high-speed steel. Grooves are milled in the sides of the machine, steel shanks and the cutters are fitted into these milled grooves, as shown, and are brazed in place.

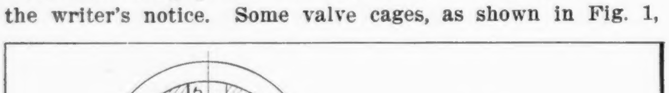
Several other methods are used in this shop which might interest mechanics, but the devices and methods shown constitute the most interesting ones and those which are most likely to be new to the majority of men interested in the manufacture of machine tools.

* * *

AN INTERESTING SLOTTER PROBLEM

By H. A. S. HOWARTH*

An interesting problem in slotter work recently came to the writer's notice. Some valve cages, as shown in Fig. 1,

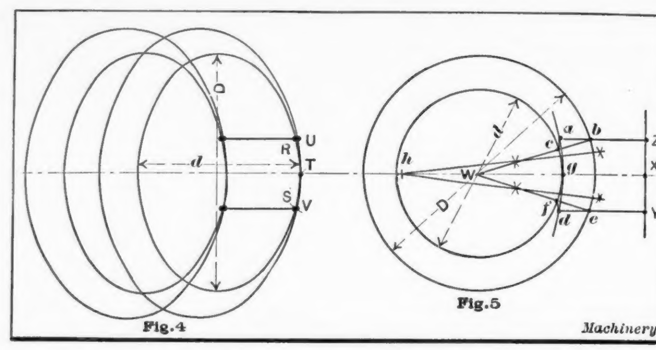


Figs. 1 to 3. An Interesting Slotter Problem and the Method by which it was solved

needed their ports *A* enlarged. This necessitated the machining of the surfaces *B* and *C*. Since these are truly conical, the ideal way to machine them would be to mount the cage on a fixture so that its axis would be at 45 degrees with the vertical, and then set the slotter tool to cut along the vertical element of the surface, rotating the cage, meanwhile, about its own axis. A circular milling attachment mounted on an angle-plate would meet the requirements. It so happened, however, that a fixture for thus rotating the cage was not at hand. Hence, some other method had to be employed.

Those accustomed to work of this character will see that an approximation of the conical surface can be produced by mounting the cage on a 45-degree angle-plate, and then revolving the angle-plate about a vertical axis *EE* as shown in Fig. 3. The question then arises: How much off the center of the slotter table should the tool be set in order to cut the surface desired? In the case in question this distance was sought by a series of trials, and the resulting surface was not very satisfactory. A simple way to predetermine this offset *OP* is explained below.

Since the tool cuts vertically and the axis of the table is vertical, the surface which will result if the table be revolved will be cylindrical. But when the valve cage is mounted on the angle-plate as in Fig. 3, and one looks down upon it, the port edges *FG*, *HJ*, *KL*, and *MN*, which really lie in circles, are seen to lie on ellipses which are tangent in pairs as indicated in Fig. 4. The curve *RTS* in Fig. 4 corresponds with the port edge *FG* of Fig. 1, and *UTV* corresponds with *HJ*.



Figs. 4 and 5. Methods used for Determining Distance OP, Fig. 3

The inner edge *FG*, Fig. 1, happens, for this cage, to be the most important. Hence the slotter must cut as nearly as possible along the curve *RTS*, which is part of an ellipse. It is evident that the surface cut will not be theoretically correct, but the error cannot be avoided. Curve *RTS* may be approximated by a circular arc whose radius must be determined. The offset *OP* of Fig. 3 equals this radius. The ellipse *RTS* in Fig. 4 has for its major axis the diameter *D* of the cage in Fig. 1. For its minor axis it has the width *d* found as in Fig. 2 by inclining the diameter *D* 45 degrees (the angle of the fixture) with the horizontal, and projecting it.

Now draw two concentric circles as in Fig. 5 with *D* and *d* as diameters. Draw a vertical *ZY* and a horizontal *WX*. Lay off *ZX* and *YX* each equal to half the chordal distance *FG*, which is the port width as found in Fig. 1. Draw the lines *Zba* and *Yed* parallel to *WX*. Connect *bW* and *eW*, thus obtaining *c* and *f*. Draw *ca* and *fd* perpendicular to *WX*, thus obtaining the points of intersection *a* and *d*. The points *a*, *g* and *d*, just found, correspond with *R*, *T* and *S* of Fig. 4. Continuing the construction, find by the usual method the center *h* of a circle that will pass through the points *a*, *g* and *d*. Its radius *hg* is the desired offset *OP* in Fig. 3.

It is now a comparatively easy matter to set up the cage and machine the surface *FGHJ*, Fig. 1, of one port opening. For the next, simply unclamp the cage and rotate it on the angle-plate to bring the next opening into position.

* * *

To show the extent to which autogenous welding has been introduced into Germany, the *Daily Consular and Trade Reports* quotes an authority's estimate that there are upward of 12,000 plants using welding apparatus throughout that country. As a means of furthering this process there is an association at Stuttgart, Verband für Autogene Metallbearbeitung, where courses in the manipulation of welding apparatus are given.

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MILLING, CROSS-DRILLING AND BURRING ATTACHMENTS—3

APPLICATION TO THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

By DOUGLAS T. HAMILTON*

In order to avoid a separate operation in manufacturing parts requiring to be cross-drilled, the Brown & Sharpe Mfg. Co. has designed what is called an "index drilling attachment." This attachment, which is used for drilling cross-holes in studs and capstan-screws, is illustrated in Figs. 16, 17 and 18. In this article reference is also made to Fig. 4, which appeared in the September installment.

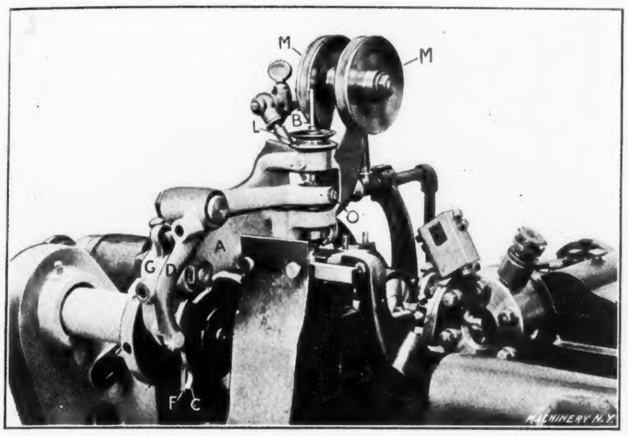

Fig. 16. Front View of the Index Drilling Attachment, placed on a No. 00 B. & S. Automatic Screw Machine

Index Drilling Attachment

The Brown & Sharpe index drilling attachment, which is shown located on a No. 00 automatic screw machine in Figs. 16 and 17, consists mainly of a cast-iron bracket *A*, fastened by cap-screws to a boss on the machine provided for that purpose. In this bracket are held the work- and drilling-spindles, the latter being held in a vertical position and in line with the work-spindle. The camshaft from which the attachment is operated, is driven by a chain and sprocket, which is shown encased in Fig. 16. A sprocket-wheel for driving the attachment is placed on the front camshaft of the machine, and an idler pulley, fastened to a bracket, gives the chain the desired tension on the sprocket. Figs. 16 and 17 give a general idea of the construction of this index drilling attachment, but for a more detailed description reference should be made to Fig. 18. Similar parts in the three illustrations bear the same reference letters.

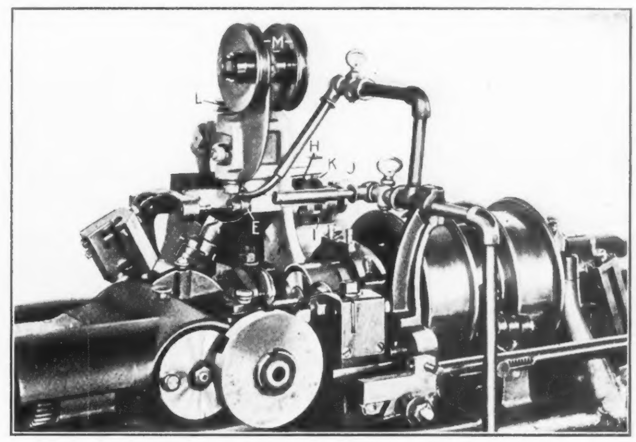

Fig. 17. Rear View of the Index Drilling Attachment in Place on a No. 00 B. & S. Automatic Screw Machine

The drilling-spindle *B* is driven by a 3/8-inch round belt from the overhead works through pulleys *L* and *M*, the pulleys *M* acting as idlers, to change the direction of the belt from a vertical to a horizontal position. Spindle *B* is operated by a cam *C* acting through a lever *D*, while the indexing of the work-spindle *E* is accomplished by a cam *F* acting through a lever *G*. The forward end of the lever *G* has teeth cut in it (see Fig. 24) which mesh with the segment gear *H* on the work-spindle *E*, Fig. 18. A ratchet *I*, held to the segment gear by a shoulder screw and nut as shown, and acted upon by a spring, fits in a ratchet disk I_1 (see Fig. 24) which is keyed to the work-spindle *E*. The locking plate *J* has V-notches cut in it, the number of which (usually four) equals the indexings of the spindle required, this plate being used for locking purposes only. A spring plunger *K* fits in the notches

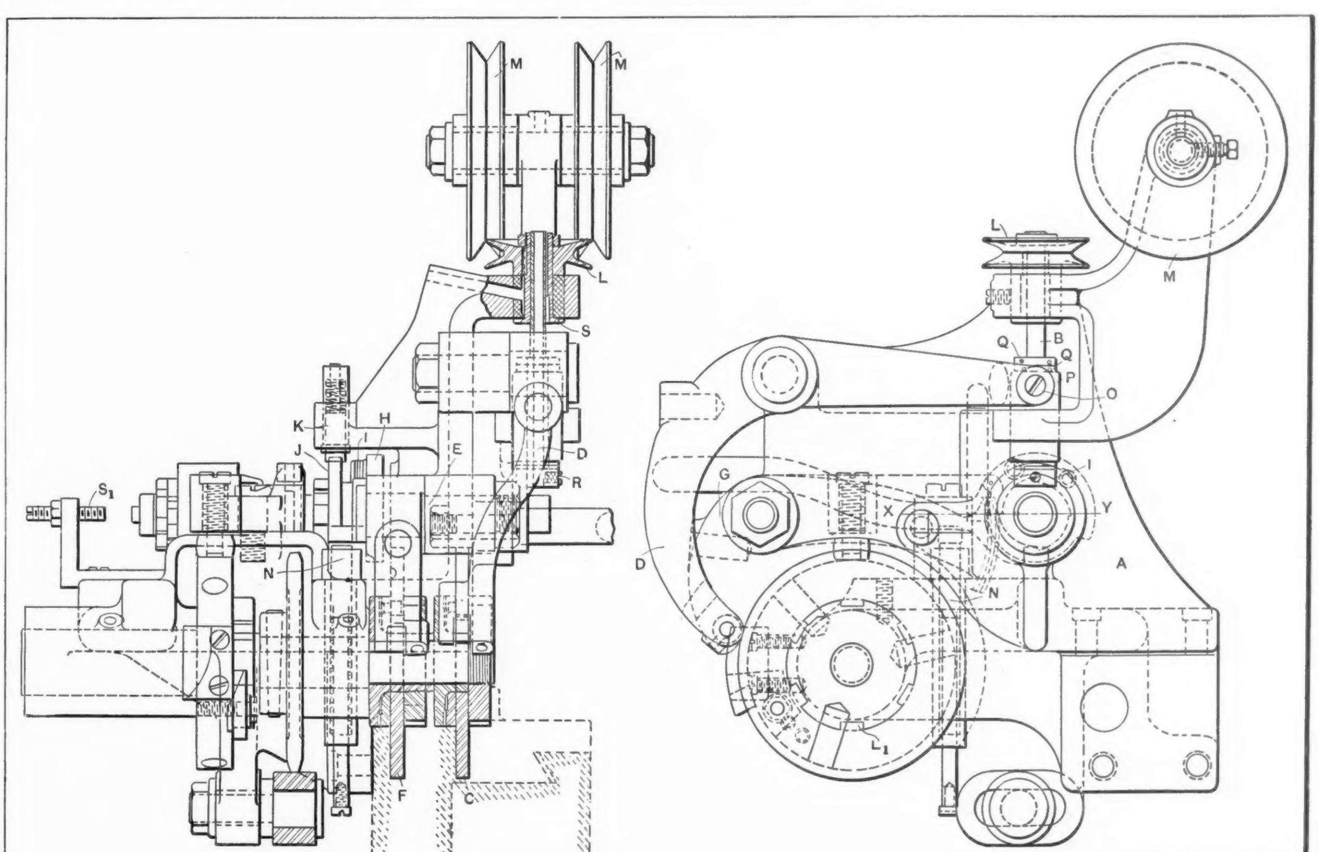

Fig. 18. Assembly View of the Index Drilling Attachment for the No. 00 B. & S. Automatic Screw Machine

* Associate Editor of MACHINERY.

in plate J and holds it in place until the spindle is again indexed.

In operation, when the indexing lever G is raised by the cam F, it depresses the spring plunger N, and at the same time rotates the segment gear H carrying the ratchet I. The spring plunger returns the lever to its normal position when the roll on the lever drops down to the smallest diameter of the cam, and in so doing returns the indexing disk H to its normal position ready for the next indexing. The work-spindle is indexed by the ratchet I meshing in one of the teeth in the ratchet disk I_1, which is keyed to the work-spindle.

The drilling-spindle B is raised and lowered by means of the lever D, which is connected to it by two screws O, holding two shoes, the latter fitting in milled slots cut in the sleeve P. This sleeve is held on the spindle B by check-nuts Q. The drill-spindle runs in bronze bearings, and is provided at its lower end with three set-screws R for holding the drill. The upper end of the drill-spindle fits in a steel bushing S, to which it is keyed. The pulley L is also keyed to bushing S, and as the spindle B is provided with a groove, it is possible to rotate the spindle, and at the same time move it up and down by the lever D.

Construction of the Index Work-spindle

Fig. 19 shows a sectional view of the index work-spindle, the section being taken on the line X–Y, Fig. 18. The spindle, as has been previously stated, is indexed, but otherwise remains stationary. The chuck A is closed by means of the cam B, which is fastened by screws to the drum D, while the cam C operates the lever M for opening the chuck. A roller L, attached to the lever M, and which is guided by the cam-blocks B and C, operates the lever M for closing and opening the chuck.

In operation, as the lever M is forced by the cam C in the direction indicated by the arrow C_1, it withdraws the clutch sleeve N from beneath the fingers O, allowing the latter to drop and release their pressure on the sleeve P. Now, as the mouth or front end of the sleeve P_1 is beveled to an angle which is greater than the angle of repose, and as the chuck A is split and spring-tempered, the withdrawal of the clutch sleeve N from beneath the fingers O allows the bevel on the chuck to force the sleeve P back, thus permitting the chuck to open and the work to be ejected by the plunger S. Inversely, as the lever M is forced by the cam-block B in the direction of the arrow B_1, the clutch sleeve N is forced under the fingers O, so that their circular bearings or ends rest on the straight cylindrical portion of the sleeve. This action on the fingers O causes the sleeve P to be pushed forward and butt against the sleeve P_1, forcing it over the tapered portion of the chuck A, and thus closing the latter on the work.

The work, when forced into the chuck A, butts against a brass ejector or stop S which is screwed onto the rod R. This rod passes entirely through the spindle R_1, and is held outward by a coil spring E. When the work forces the ejector S into the chuck, the head on the rod R comes against the stop-screw S_1, which is clamped by the lock-nut shown. The position of the stop-screw governs the distance to which the work can be inserted in the chuck, thus locating the position of the drilled holes. The desired grip of the chuck A on the work is obtained by adjusting the check-nuts G. The work-spindle can be taken out by removing the nuts H and I and the lever M.

Laying Out Cross-slide Cams for Cross-drilling Operations

The method of laying out a set of cams for a cross-drilling operation is similar to that for any other job, except that there are a number of special points to be considered which relate chiefly to the clearance allowances for the transferring arm in its ascent and descent to and from the work-spindle. Possibly the best way to illustrate the method employed is to take a practical example and describe each step in the calculation. Assume that it is necessary to make the piece shown at A in Fig. 20, which is a binding post, made from 9/32-inch brass rod. The turret and cross-slide cams, also shown in this illustration, are laid out in the usual manner, except that sufficient space is allowed, as shown from 86 to 91 (on the cam circumference), for bringing down the transferring arm to grip the work. One hole should be left vacant in the turret, so that the transferring arm can be brought down without coming in contact with any of the turret tools.

Before laying out the lead and cross-slide cams, it is preferable to make a lay-out as shown in Fig. 21, drawing in the position of the circular form and cut-off tools and also the tools used in the turret. If this is done, the amount that the cams are to be cut done below the largest diameter of the cam circumference, and also the clearances necessary for the turret and circular form tools, can be found. After the necessary information has been obtained from this diagram, another diagram, such as in Fig. 4, should be made, so that the rises and the cut-downs on the transferring and advancing cams can be obtained. Of course the example given in Fig. 4 applies more particularly to a screw-slotting job; the method of procedure, however, for laying out the cams used on the index drilling attachment is similar.

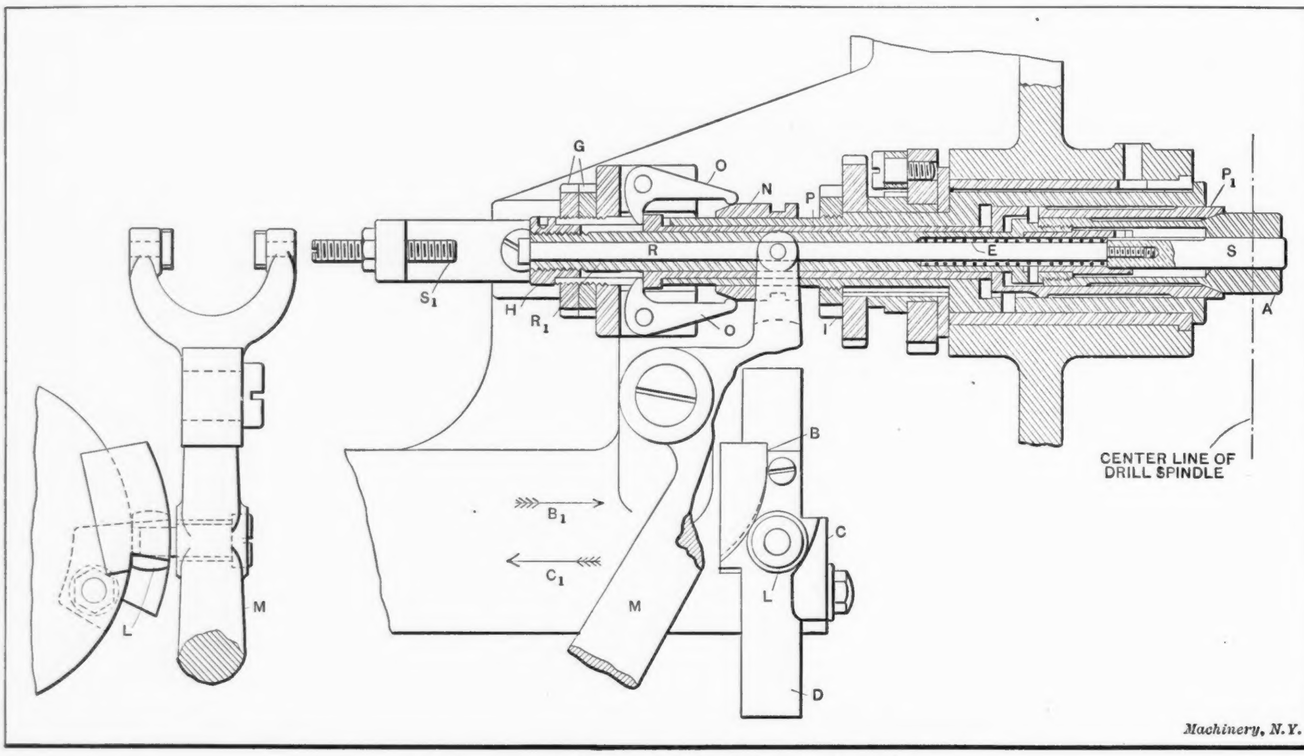

Fig. 19. Sectional View of the Index Drilling Work-spindle

Laying Out the Transferring and Advancing Cams

As the method of laying out the transferring and advancing cams has been described in a previous installment (see September number of MACHINERY), it will not be necessary to describe it here. The drawing of the transferring and advancing cams used in connection with the piece shown at *A* in Fig. 20, is shown in Fig. 22. Here the lobes and their uses are clearly indicated. The lay-out of these cams does not differ materially from that for a screw-slotting job except, of course, that the lobes on the advancing cam are made with a dwell, no feeding movement being necessary. To determine

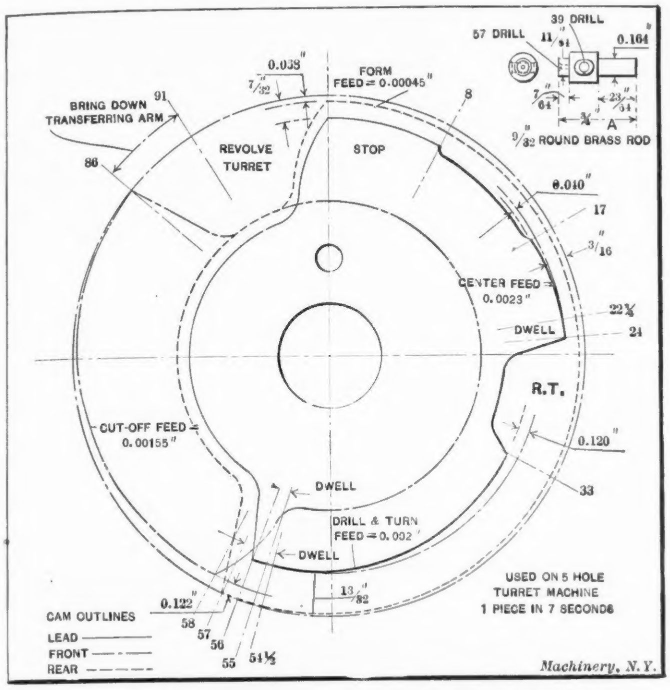

Fig. 20. Lay-out of a Set of Cams for a Cross-drilling Operation on the No. 00 B. & S. Automatic Screw Machine

the relative heights of the lobes *A* and *B* on the advancing cam, a diagram similar to that shown in Fig. 4 should be drawn, in which the slotting saw should be replaced by the chuck *A* and stop *S*, shown in Fig. 19. The lobe *A*, Fig. 22, should be of sufficient height to force the work into the chuck to the proper distance, and thus locate the stop *S*, Fig. 19, up against the stop-screw S_1.

Laying Out the Indexing and Drilling Cams

In laying out a set of indexing and drilling cams, it is always preferable to start from some predetermined point.

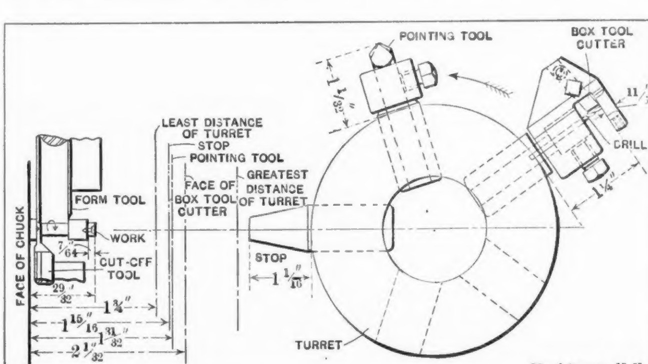

Fig. 21. Diagram for Obtaining the Cut-down on the Lead Cam, and Clearance for Tools

The practice usually followed by the writer is to allow 1½ hundredth clearance between the finishing point on the inserting lobe *A* (see Fig. 22) and the starting point *A* on the drilling cam, Fig. 23, and then lay out the corresponding lobes on the drilling and indexing cams from this point. As soon as the advancing roller is on the top of the lobe *A*, Fig. 22, the index drilling chuck should be opened, and closed again before the roll drops off the lobe. About one hundredth of the cam surface should be allowed for clearance, so in this case the chuck should be opened at 4 on the cam circumference. The chuck is opened by the cam *C* on the drum *D*, Fig. 19, in the manner previously described.

The indexing and drilling cams used for drilling the binding post shown at *A* in Fig. 20 are shown in Fig. 23. Here it can be seen that the drill begins to operate at 5½ and finishes at 52, one one-hundredth being allowed for the drill to make a smooth finish. The order of operations for the lead, cross-slide, advancing, transferring, drilling and indexing cams is given in the following:

Lead and Cross-slide Cams

Order of Operations	Revolutions	Hundredths
Feed stock to stop and chuck..........	22.40	8
Revolve turret	25.20	9
Center 0.040 inch rise at 0.0023 inch feed, dwell 0.125	19.60	7
Revolve turret	25.20	9
Drill and turn with box-tool 0.120 inch rise at 0.002 inch feed, dwell 0.15....	64.40	23
Form with circular tool 0.058 inch rise at 0.00045 inch feed, dwell 0.25.......	(159.60)	(57)
Clearance	5.60	2
Cut-off 0.122 inch rise at 0.00155 inch feed, and revolve turret	78.40	28
Clearance for transferring arm	14.00	5
Revolve turret	25.20	9
Total	280.00	100

Transferring and Advancing Cams

Order of Operations	Revolutions	Hundredths
Place transferring bushing on work....	11.2	4
Drop arm back from work	5.6	2
Lift up transferring arm.............	20.2	7¼
Clearance	2.8	1
Dwell with transferring arm while placing work in chuck and drilling	187.6	67
Place work in index drilling chuck....	21.0	7½
Dwell with arm while closing chuck...	11.2	4
Drop back arm	14.0	5
Dwell with arm while drilling.........	131.6	47
Drop down transferring arm to pick up piece	30.8	11
Clearance	2.8	1
Advance to put bushing on work......	11.9	4¼

Drilling and Indexing Cams

Order of Operations	Revolutions	Hundredths
Drill and countersink 0.218 inch rise at 0.0017 inch feed, dwell 0.10..........	127.4	45½
Lift out drill	9.1	3¼
Push down lever to index	11.2	4
Dwell to allow spring to return lever	4.9	1¾
Index second time	22.4	8
Dwell to allow spring to return lever.	4.9	1¾
Clearance	9.1	3¼
Countersink 0.062 inch rise at 0.0031 inch feed, dwell 0.10	22.4	8
Pull out drill, open chuck, and allow clearance, to drop and raise transferring arm and close chuck.........	65.8	23½

Referring to Fig. 23, it will be seen that the indexing cam is provided with two projecting lobes *B* and *C*, which are used to force the lever down and thus rotate the indexing disk. These two lobes are necessary because the piece to be drilled has only one cross-hole countersunk on both sides, which necessitates indexing the spindle four times for each piece. Since the indexing and drilling cams rotate at the same speed as the turret and cross-slide cams, the time required for indexing is approximately equal to the time required for feeding the stock, which can be verified by referring to the illustration, the space required being from 61 to 69. Three hundredths of the cam surface is the minimum space which should be allowed, on account of the rolls requiring that space to drop down. A milling cutter at least 1/16 inch larger in diameter than the roll should be used for cutting the cams.

The motion transmitted by the cams to the indexing and drilling levers *G* and *D* is clearly shown by the full and dotted lines in Fig. 24. The maximum travel of the index drilling spindle is equal to the distance *A*, this dimension also being the difference between the largest and smallest diameters of the cam. The distance *A* on the attachments used on the various Brown & Sharpe automatic screw machines is as follows:

No. of Machine	Distance A in Inches
00	9/16
0	3/4
2	1 3/16

The maximum diameters of the indexing and drilling cams for the attachments used on the various machines are as follows:

No. of Machine	Diameter B in Inches
00	4
0	4 1/2
2	4 1/2

The cut-down required on the cam for indexing can be found by laying out a diagram similar to that shown in Fig.

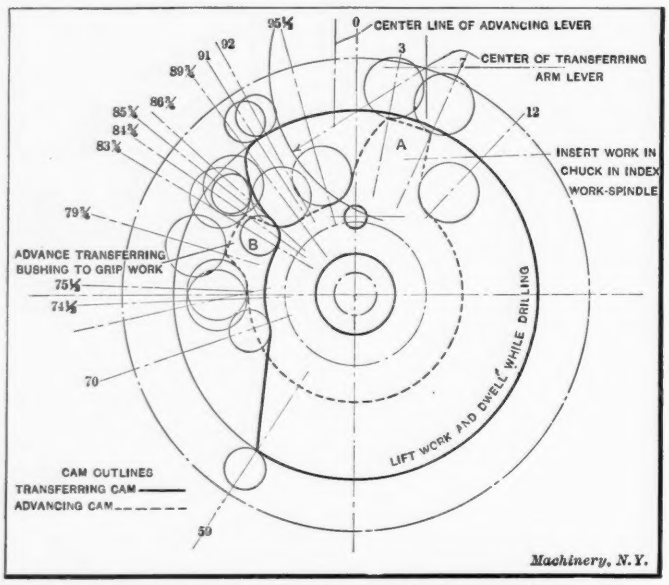

Fig. 22. Transferring and Advancing Cams for Lifting and Placing the Work in the Index Drilling Chuck

24. When the indexing disk I_1 is provided with six teeth instead of four, the cut-down required will be, of course, proportionately less.

Speeds and Feeds for Cross-drilling

The speeds and feeds used for cross-drilling do not vary from those used when drilling from the turret, and to obtain the required speed for the drill a grooved pulley of suitable size should be placed on the countershaft. The drilling speeds

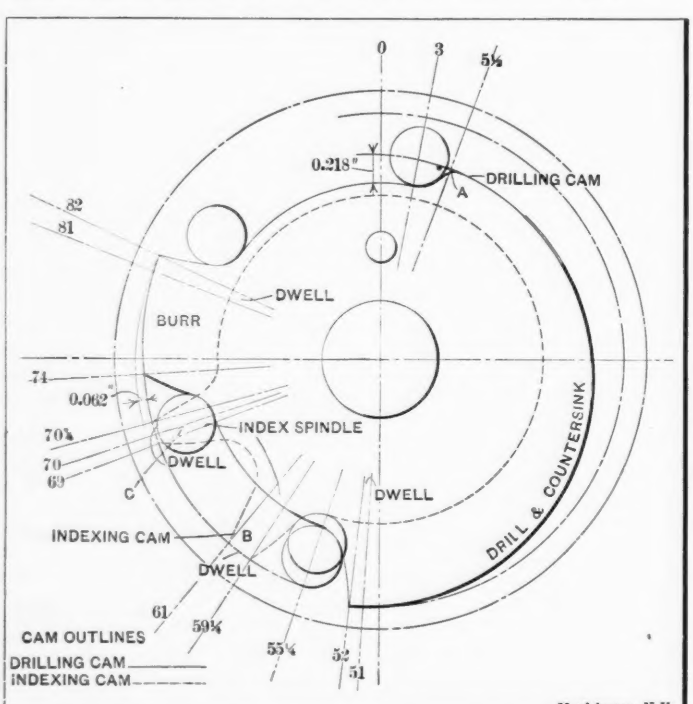

Fig. 23. Indexing and Drilling Cams for the Piece shown at A in Fig. 20

and feeds for ordinary carbon and high-speed twist drills for drilling different materials were given in the September, 1910, number of MACHINERY.

Transferring Bushings

When transferring a piece of work from the work-spindle to the index drilling spindle, it is necessary to have a transferring bushing which will insert the work in the index drilling chuck. The ordinary screw-slotting bushing cannot be used for this purpose, except when the work is sufficiently long and the hole in a suitable place, so that the work can be inserted in the chuck without the aid of a spring plunger. When the work is not of the character specified, it is necessary to use a transferring bushing in which is placed a spring plunger for inserting the work in the index drilling chuck.

At *A* in Fig. 25 is shown a capstan-screw and the transferring bushing used for inserting it in the index drilling chuck. This screw, as shown, has two holes drilled clear through the head at right angles to each other. The transferring bushing consists of a shell *a* which is held in the transferring block. Inserted in this shell is a spring plunger *b*, pressed outward by a coil spring *c*, this coil spring being retained in the bushing by means of the nut *d*. The hole in the spring plunger should be larger in diameter than the body of the screw, so that the work can be inserted easily into the plunger. The type of transferring bushing shown at *A* is suitable for capstan-screws and similar work.

Another transferring bushing for holding a binding post is shown at *B*. This bushing differs from that shown at *A* in that it is provided with a spring chuck as well as with a plunger. The reason for this was that the piece had to be inserted in the chuck to such a distance that it was necessary for the chuck *e* to retreat so that the work could be inserted.

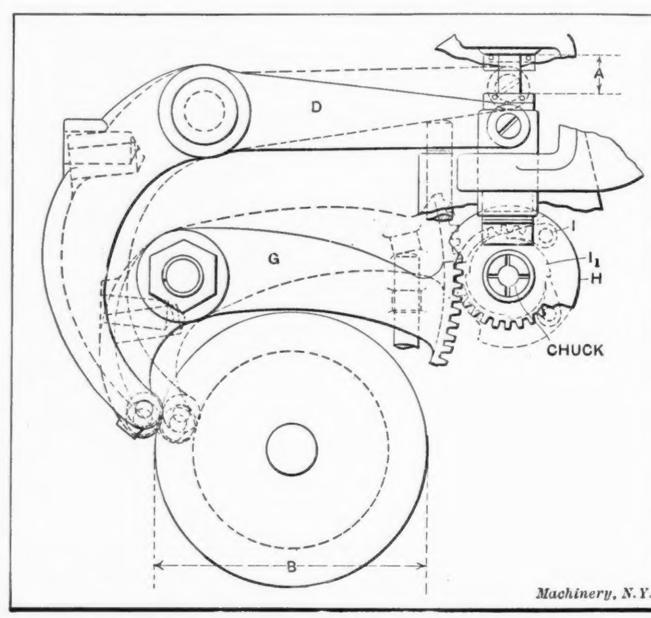

Fig. 24. Diagram illustrating the Movement of the Indexing and Drilling Levers

This transferring bushing was not a success on account of this combination arrangement of spring chuck and plunger. Difficulty was encountered with the spring chuck *e*, because of the variations in the diameter of the stock. When the stock was much greater in diameter than the hole in the chuck, the chuck was forced back into the holder so that the work was not held, as the plunger *f* kept it out.

Owing to the short amount of grip on the work, it had to fit snugly in the bushing, or it would drop out while being transferred from the work chuck to the index drilling chuck. To overcome this difficulty several methods were adopted. First, the spring *g* was made stiffer, so that when work slightly larger than the hole in the chuck was encountered, it could be inserted without pushing back the plunger. This overcame the difficulty of placing the work in the chuck *e*, but when the latter was transferred to the index drilling chuck, the work could not be ejected from the chuck. The spring *h* was made stiffer, but this brought about the same conditions as before, and prevented the work from being located properly in the chuck *e*.

This type of bushing was finally discarded and the one shown at *C* was adopted. This bushing consists of an outer sleeve *k*, as before, in which is screwed a stationary holder *l*. A chuck *m* is made a sliding fit on holder *l*, and also in the sleeve *k*, and is pressed outward by a spring *n*. This spring acts against a washer *o*, which is beveled, as shown, to reduce

the friction, thus preventing the spring from being twisted in the holder when work of larger diameter than the chuck is encountered, causing the chuck to rotate. The hole *p* in the holder is made slightly larger than the diameter *Q* on the work, while the hole in the bushing *m* is made slightly larger than the largest diameter of the work. The holder *l* is slabbed on both sides on the front end, as shown in the end view, and the index drilling chuck is cut out so that this holder can be inserted in it, thus carrying the work right into the chuck. This bushing proved very satisfactory, both as regards gripping the work and inserting it in the chuck, and was used on the piece shown at *A* in Fig. 20.

A transferring bushing of a different type is shown at *D*. This bushing, instead of passing over the work, has a plunger *r* which is inserted in a hole in the work. This plunger is slotted, as shown, and a flat spring *s* is held to it by a screw. Spring *s* is curved and rounded so that it fits snugly in the work. The plunger *r* is held out by a coil spring *t*, and is

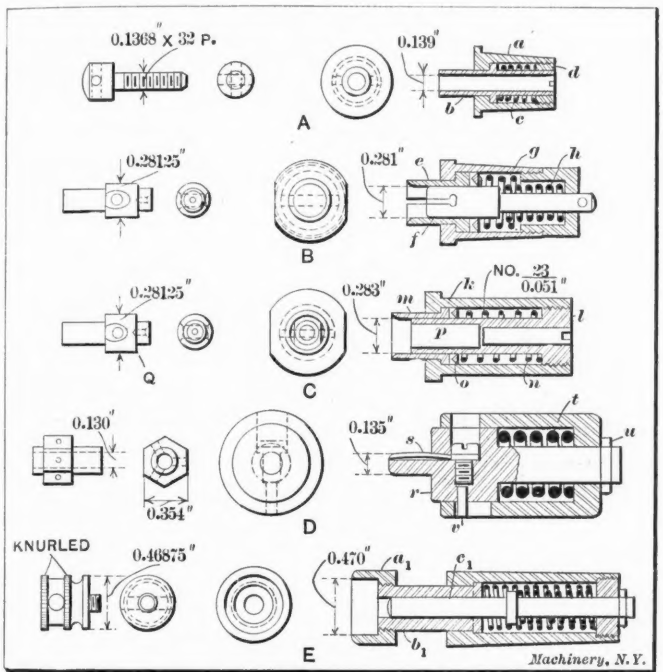

Fig. 25. Representative Types of Transferring Bushings and the Work they were designed to hold

retained by a pin *u*. A small pin *v*, driven into the plunger and fitting in a slot cut in the bushing, prevents the plunger from rotating. As shown in the illustration, this bushing is not tapered on the shank, but is perfectly straight, so, obviously, a special transferring block had to be made to hold it.

Another type of transferring bushing is shown at *E*. This bushing has a marked resemblance to that shown at *B*, but gives satisfaction because of the character of the work. The hole in the chuck a_1 could be made larger than the diameter of the work, and still the latter would not drop out; thus the difficulty of inserting the work in the chuck is overcome. The hole in the plunger b_1 to which the chuck is attached is made larger than the teat or threaded part on the work. A spring plunger c_1 is used for inserting the work in the index drilling chuck. Obviously, there are a number of different types of transferring bushings used, but as those shown incorporate the principal features of bushings of this type, it would seem that any further descriptions are unnecessary.

* * *

A new "regular" airship service has been announced in Germany. Excursions will be made by the Zeppelin airship *Schwaben*, which will make its headquarters at Baden-Baden. From here trips lasting from one-and-one-half to two hours will be made to different parts of the Black Forest and the Rhine Valley. The fare will be 200 marks ($47.60). The well-appointed cabin of the airship accommodates twenty-four persons, and large observation windows give good views of the country traversed. Cold meals are furnished on board. The *Schwaben* is 475 feet long, has three engines developing 375 horsepower, and its average speed is 33 miles an hour.

THE CORRECT USE OF HARDENING-ROOM TERMS*

There are many terms and expressions in the hardening-room which are loosely used, and in some cases confusion of thought results. Some expressions which are incorrect in themselves have so passed into current use that they must, perhaps, be tolerated and made the best of. For example, when a man says that his tools are "too hard" he almost always means that they are too brittle. Surely the hardness is a good thing, and for most purposes a tool cannot be *too hard*. Even a punch, which under existing circumstances ought to be tempered until it can just "be touched by a file," would be much better if it could be made glass-hard and at the same time so tough that it would not break or chip. As a matter of fact, the punch must be tempered until it loses some of its hardness, not because it is *too hard*, but because it is *too brittle*. It would be better if the brittleness could be removed without impairing the hardness. The loose expression has established itself because the ideas of hardness and brittleness are so intimately associated in men's minds that frequently they can hardly be dissociated. There are times, however, when the expression which is so frequently misused is really required in its correct sense; for example one sometimes uses a lead or copper hammer instead of a steel one, because the steel hammer would be *too hard* and would bruise the work.

Carburet, Carbonate, Carbonize, Carburize

The words "carbonize" and "carburize" are sometimes used interchangeably, but each has its distinct meaning, as also have the words "carburet" and "carbonate."

A dictionary definition of "carburet" is "to combine chemically with carbon" and it is generally applied to gases; for example, carbureted hydrogen, or marsh gas, is a compound of carbon and hydrogen represented by the chemical formula CH_4. "Carbureter" appears in the dictionary as "an apparatus for charging hydrogen, coal gas, or atmospheric air, with carbon by passing it over a liquid hydro-carbon."

The verb "to carbonate" is now obsolete, but once it was in general use meaning "to burn to carbon." In Fraser's Magazine, III, 1831, reference is made to some witches who "were carbonated because they unreasonably resisted drowning in the mill-race." Happily the practice here referred to is even more obsolete than the word used to describe it. The word "carbonated" is largely superseded by "carbonized," which is defined as "converted into mere carbon, reduced to charcoal, or coke." Bone dust and leather scrap are frequently used for casehardening, sometimes in the raw state, sometimes after they have been carbonized.

When mild steel articles are heated in casehardening material they are frequently spoken of as being carbonized, but this is a misuse of the word. It is correct in this case to say the articles are carburized. In casehardening there are two processes, the first consisting of imparting carbon to the surface of articles made of iron or mild steel, so that they acquire a skin of high-carbon steel. This is the process of carburization. Work which has been thus carburized may then be hardened by quenching it in water from a red heat, as if it were made of carbon tool steel.

Hardening and Tempering

Although the mistake is rarely made in the hardening-room itself, it is surprising how often engineers speak of "tempering" when they mean "hardening." The process of hardening consists of raising the steel to a proper red heat, and then cooling it rapidly by quenching in water, or by other means. The tempering is a further process of heating the steel to a much lower temperature than for hardening, and the effect is to toughen the steel, and also, unfortunately, to soften it somewhat. The first process is sometimes erroneously called tempering, and more frequently this word is applied in general terms to the two processes together, but it is clearly wrong to do this. The distinction is made not simply by a purist in the use of correct language, but because the processes are so distinct that it is very frequently necessary to distinguish between them.

* Abstract of an article by Shipley N. Brayshaw in the *Engineering Magazine*, September, 1911.

SPINNING KETTLEDRUM SHELLS*

A pair of kettledrums is considered indispensable to a first-class orchestra; sound effects can be produced with them that are unattainable with other instruments, and the kettledrummer is one of the highly skilled musicians, although his antics in a difficult composition sometimes cause more amusement than admiration.

The kettledrum is an instrument consisting of a hemispherical copper shell with a skin stretched over the open end to form the head, and is usually mounted on a tripod base. The shell is made from one piece of copper, which in years gone by was beaten into the required hemispherical shape with hammers. The cost of a pair of drums made in this

Fig. 1. Pair of Kettledrums with Spun Copper Shells

way was high, amounting to $400 or $500. Thanks to improved methods of forming the shells, the cost has been greatly reduced, a pair now being worth about $75, which is an amount easily within the reach of almost any good orchestra.

The illustration Fig. 1 shows a pair of kettledrums with spun copper shells made by Mr. John J. Pole of Geneva, N. Y. Mr. Pole has developed an effective and interesting metal spinning practice in his efforts to make these instruments.

Fig. 2. Pole's Metal Spinning Shop

He is an amateur in the sense that he never served an apprenticeship in any mechanical trade, and his success is more remarkable because of certain physical infirmities in youth that prevented him from acquiring an education. He was born in England and came to America about twenty-five years ago. Being fond of music he became interested in musical instruments of all kinds, and was for several years a piano dealer in Geneva.

The need of a pair of kettledrums for an orchestra composed of musical friends led to his efforts to make them. His first pair was made with wooden shells; these were useful, but their chief value was in proving certain theories he had formed as to the possibility of making successful drums from other materials than beaten metal, and further experiments convinced him of the possibility of making the shell from spun copper. He knew nothing of metal spinning and could find out little about it by visiting nearby shops, but with

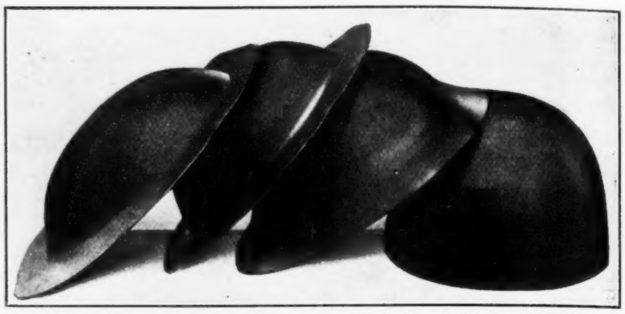

Fig. 3. Showing Steps in Process of Spinning Kettledrum Shell

the information that could be obtained and his own ideas he built a lathe and started to spin shells from flat copper plates. The first attempts were rather costly failures, but success finally crowned his efforts.

Fig. 2 shows the little spinning shop that Mr. Pole has built back of his home on Sharon St., and beside it at the left is his annealing furnace. This is provided with gas burners and simple appliances for annealing the shells, all of home-made construction.

The shells are spun in the lathe, which was made by Mr. Pole as were also the chucks and tools. Fig. 4 shows the wood

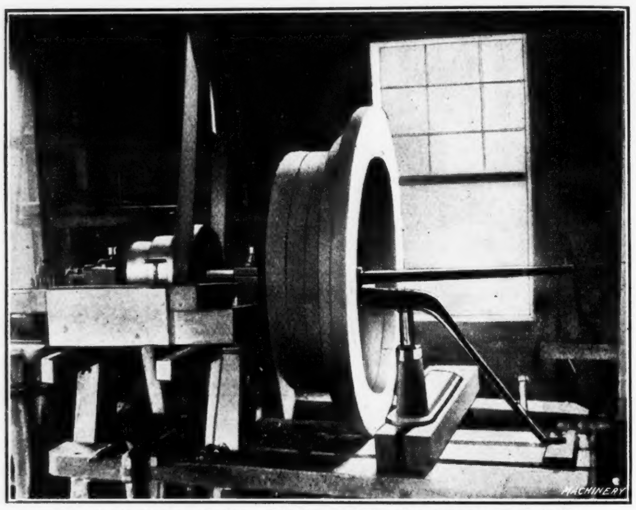

Fig. 4. Spinning Lathe with Large Wooden Chuck on Spindle

chuck, mounted ready for use, in which the shape is started, the flat plate being forced into the shallow recess with wooden levers supported on the curved rest. The rest is provided with a row of holes in which pins are placed to act as fulcrums. The headstock is of cast iron, but the frame and legs

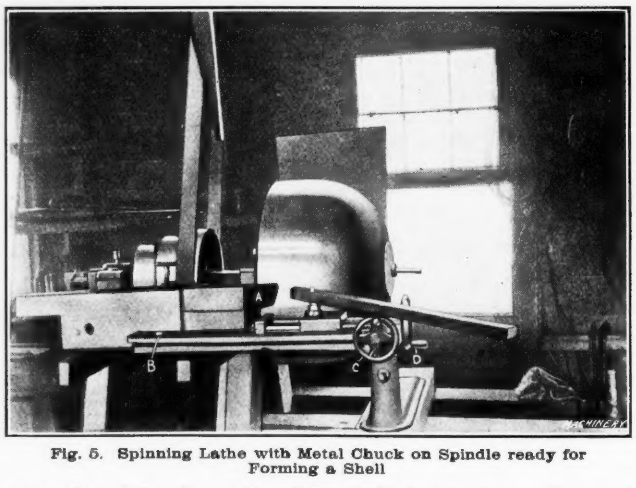

Fig. 5. Spinning Lathe with Metal Chuck on Spindle ready for Forming a Shell

are made of hard wood solidly bolted together. Power is furnished by a gasoline engine. Fig. 3 shows the progression of the process of spinning a kettledrum shell, the first piece at the left being the shape produced in the wood chucks, while a finished shell is shown at the right.

* For further information on metal spinning, see MACHINERY, June, 1911, "Gold and Silver Spinning," and articles there referred to; also Reference Book No. 57, "Metal Spinning."

The most difficult part of the process is rolling over the outer part of the plate, which forms the upper part of the shell, without producing wrinkles. The thin metal tends to buckle under the pressure of the tools and will do so unless firmly supported by a rest interposed between the shell and the chuck. The second step in the spinning process is performed on the same lathe, using hollow cast-iron chucks of the form shown in Fig. 5. This view also shows the compound iron rest and the wooden piece *A* with tapered end that supports the inside of the shell as it is being laid over against the chuck by the tool. The iron rest is pivoted at *B* and is provided with a handwheel *C* that is used to force the tool against the work. Another handwheel *D*, at the end, adjusts the rest longitudinally with the shell, and provides means of placing the fulcrum at the exact spot wanted. Wood

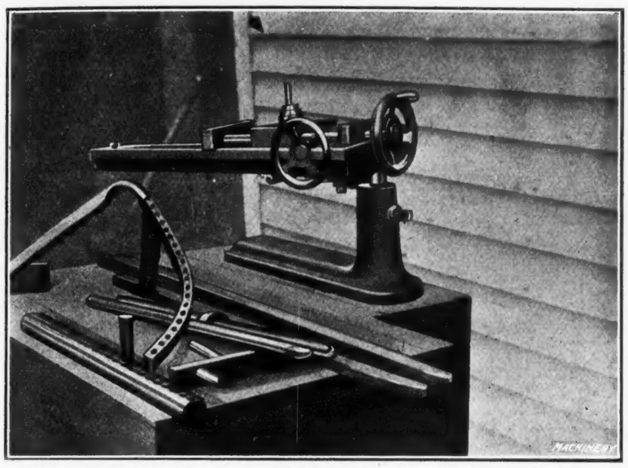

Fig. 6. The Rests and Principal Tools used for Spinning Shells

levers are employed chiefly for rolling over the shell, but steel bars with shaped ends are also used for finishing.

The adjustable wooden support or rest *A* is an important part of the equipment. It slides in a channel or box beside the headstock and is frictionally held by a screw whose handle shows in front of the second step of the cone pulley in Fig. 5. Very little pressure suffices to hold the rest when the metal is soft, but as it grows harder with working, more friction is required and the operator tightens the screw as the spinning proceeds. In spinning light work, the common practice is to hold a stick behind the metal back of the tool, but the frictionally held rest is far superior. Since Mr. Pole

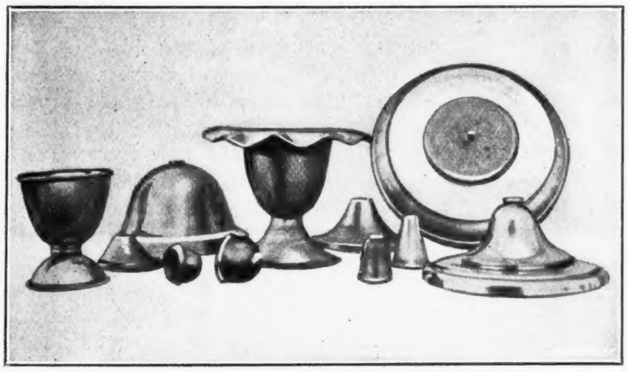

Fig. 7. Samples of Spun Art Work

devised this rest he has never had a piece break on the edge and he has found that the metal can be worked fully twice as much without annealing, as it can without the firm back-rest.

As the shell is formed against the iron chuck the end of the wooden support *A* is gradually forced back out of the way, but all the time the metal is held between it and the end of the tool. In this manner, the metal is forced to compress without buckling and to lie smoothly on the chuck. So perfectly does it embrace the chuck body that it makes an air-tight fit, and it is necessary to work the tools so as to let the air escape before finally closing down the shell, as the imprisoned air would distort the shape and cause trouble. The collection of tools and rests shown in Fig. 6 comprises practically all the appliances employed in forming the shells in the lathe, excepting the back-rest *A*. The edge of the shell is rolled over inwardly after the completion of the spinning process, to stiffen it and form a bearing for the calfskin head, this being another and distinct operation.

Mr. Pole has worked up a considerable business in the manufacture and sale of his kettledrums; he also does spinning work to order. Samples of some of the shapes produced are shown in Fig. 7. F. E. R.

* * *

SYSTEMS OF DIMENSIONING DRAWINGS

By I. E. HALL*

A comparison of a number of working drawings used in various shops throughout the country reveals the fact that all drawings are not dimensioned by the same system; the systems used may be divided into four classes: *viz.*, the metric system, the decimal system, a system with all fractions expressed as common, and a system combining both common and decimal fractions. Users of these various systems claim merit for the one of their own choosing, but a careful study of the situation seems to point out that the fourth system is the best all-around one for working drawings.

The first-named—that is, the metric system—possesses the advantages peculiar to the entire metric system of measurements, and is especially valuable when drawings are to be sent to foreign countries. Its disadvantages, though, are more numerous; for instance, all raw stock such as bar metal, lumber, wire, screws, piping, hardware, etc., are sold with sizes designated by the English system. The use of the metric system, of course, involves the continual calculation of equivalents in inches, which naturally is a fertile field for mistakes. Another strong objection to the common use of the metric system is the fact that the greater number of mechanics' measuring tools, such as scales, rules, calipers, gages, etc., are marked in inches, and there again much figuring is left for the workman to do—a proceeding which is always admitted to be bad practice.

That there could be any serious objection to a straight decimal system of dimensioning drawings might seem rather odd to the novice, but such an objection does exist in the fact that no distinction is made by the figures—that is, there is nothing to distinguish between the dimensions which must be followed to one-thousandth inch, and those whose exactitude is not of much importance, and where a rigid adherence to the decimal figure is a waste of time. A striking example of this point was brought to the writer's attention on one occasion during the manufacture of a number of brass disks for a carbureter. The drawings in question showed a number of disks, some 1/8 inch and some 5/32 inch thick. For the proper working of the carbureter, the 5/32-inch disks were required to be within one-thousandth inch of the dimensions given on the drawing, while the 1/8-inch disks could have varied 1/32 inch without causing trouble. As the workman who made these parts was not familiar with the assembled product, he turned both sizes of disks to 0.125 inch and 0.15625 inch, respectively. Of course, no harm was done, but the time spent in carefully turning the 1/8-inch disks to exactly 0.125 inch was in a sense wasted and when the time was multiplied several thousand times the total was considerable. Strictly speaking, 1/8 inch is merely another way of writing 0.125 inch, but in common shop practice it is different, as sizes called for in common fractions are laid out with the ordinary machinist's scale, which is cheaper and quicker than working to the micrometer, when extreme accuracy is not required.

The third system, that of using common fractions entirely, is used exclusively in trades where it is almost impossible to work closer than 1/64 inch, such as wood-working, leather work, masonry, etc., and if decimal fractions were given it would be obviously impractical to have them followed any closer than could be read on the ordinary scale. With the exception of the trades mentioned, or similar ones, the evidence seems to be in favor of the mixed system, as being the most economical and providing fewer chances for error than any of the other methods, which fact seems to be well supported by its wide use throughout the machine shops of this country.

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THE EXTRUSION PROCESS

Some of the most interesting developments of metal shaping during the past few years have been in press working and extrusion. The distinction between the two processes is defined by the difference in action of the metal worked with reference to the punch, or plunger, and the die. In press work the metal is extended or compressed while confined on both sides by the punch and die, and its shape is defined by the dimensions of the manipulative parts. In the extrusion process the flow of metal once started in conformity with the shape of the punch and die continues outside of their confines to a distance limited only by the quantity of material in the blank and the power of the press. The metal is squirted like so much wax, and can be made to have any required cross-sectional shape.

The article on extrusion in the October number, engineering edition, and the one on the subject in this number, treat of two distinct developments. The first had to do principally with the extrusion of soft metals or metals made soft by heat into solid bars of various cross-sectional shapes. Heavy powerful hydraulic presses capable of exerting many tons pressure are required for extruding brass or bronze shapes. The second article treats of the cold extrusion of copper, tin, zinc, aluminum and their alloys, by ordinary crank presses. While extrusion of special shapes by the hot process is of great interest and value, the ingenuity and wide field of application of the second process easily gives it the first place in general interest. Like so many other valuable processes the first hint of its possibility seems to have resulted from an accident, and again like so many other developments a great deal of time and money have been required to perfect it.

* * *

UNPROTECTED POWER TRANSMISSION CHAINS

A machine designer worthy of the name will carefully provide oiling facilities for every bearing, and if the machine is exposed to flying dust he will provide guards to exclude the dust from the bearings. In view of the care generally displayed to provide safeguards for ordinary bearings, the recklessness with which machinery power transmission chain is exposed to the elements is hard to understand. It is one of the anomalies of machine construction that should disappear.

A machinery transmission chain consists essentially of a series of journals and bearings. These bearings work through an arc of limited extent, usually under high unit pressures, every time they pass over the sprockets. They require lubrication, and are injuriously affected by dirt the same as any other bearing. Why then should the transmission chains of auto-trucks be allowed to run without a case or any protection whatsoever from the mud and dust of the streets? The practice is indefensible and should be abolished. An uncovered chain is noisy and soon becomes inefficient because of wear.

A well-known manufacturer of machinery chain published the results of a test made on two chains, one working in a case in an oil bath and the other under ordinary conditions. The encased chain ran 6000 miles under heavy load and the elongation in 90 inches was only about 1/16 inch, or less than 0.001 at each link. The other chain elongated 1 inch after driving 3000 miles. While the unprotected chain was still in fair shape, it was not as efficient as when new, the links having worn out of pitch. A chain deteriorates more rapidly after it has worn appreciably out of pitch than before because of the tendency to mount the sprocket teeth. An unprotected chain is an offense against all the moral precepts of machine design.

* * *

ADVANTAGES OF HERRINGBONE GEARS

A valuable characteristic of helical gears working on parallel shafts is the absence of sliding action, the larger part of the load being transmitted by the tooth surface at or near the straight line joining the centers where the action of mating teeth is an almost pure rolling contact. They differ from spur gears in this respect: the latter have a mixed tooth action, beginning with sliding contact at the moment of engagement, changing to rolling contact at and near the line joining the centers, and ending with sliding contact when they pass out of engagement.

Spur tooth action wears the teeth most on the addendum and dedendum parts, tending to leave a hump on the pitch circle sections. The same action takes place with helical gears, but the rounding off of the flanks and faces serves to relieve them and thus reduce the friction of approach and retreat. When thus relieved, the pitch circle sections carry the load with a minimum of sliding action and friction. Hence while spur gear teeth tend to wear out of shape and become noisy, helical teeth wear into better shape when properly proportioned, and become more efficient.

A drawback to the helical gear is the end-thrust resulting from the angularity of the teeth. The end-thrust can be balanced by using a gear of the opposite pitch on the same shaft, when the end-thrust of the right-hand gear balances that of the left-hand gear. This combination, called the "herringbone" gear, is well known, being much used for heavy power transmission, especially in rolling mill machinery.

The herringbone gear, as commonly made, costs about twice as much as an equivalent spur gear and is somewhat difficult to assemble so that each gear will carry half the load. These drawbacks have overshadowed its advantages for ordinary uses, and as a result its use is almost unknown in the general run of machinery. But the advent of the hobbing process of cutting helical gears, which for the Wuest design enables integral herringbone gears to be cut very cheaply, has made them available on the score of cost wherever spur gears are commonly used. Their advantages are such that machine designers cannot afford to longer neglect them.

Take for example planetary gearing. The planetary train can be designed to give almost an infinite velocity ratio in a very small compass and with a few gears, but the frictional losses are so great with spur gears that it has been used only for hoisting and other mechanisms in which efficiency is a consideration of lesser importance than self-locking or large velocity ratio characteristics. We believe that with herring-

bone gears and annular ball bearings the planetary gear can be used advantageously in place of worm-gearing, being practically as compact for a velocity ratio of 10 to 1 or more, noiseless and more efficient. The working parts of the herringbone planetary gear under heavy load are in rolling contact, whereas in the worm-gear they are in sliding contact, which means loss of power, heating and destructive wear. Let us try out the planetary gear under new conditions and find out its possibilities.

* * *

SAFETY RULES AND DEVICES

In the following pages will be found a number of articles and rules for safety of life and limb in machine shops. We need make no apology for giving up such an amount of space to this important subject. Americans have been reckless and prodigal in the development of their national resources and likewise reckless and prodigal in the sacrifice of lives and limbs. The time has come to conserve not only our natural resources, but human life as well. Aside from sentiment, we all must recognize the great economic waste that grows out of injuries in manufacturing.

The subject of safety is so broad that we must look for specialization in the various lines of engineering. We can formulate certain basic rules for safety provisions, but the conditions must vary so widely between the mine and the machine shop that the expert, competent to provide for the former, would be incompetent to provide for the latter, and *vice versa.* We have, therefore, in the articles referred to, confined the subject mainly to machine shops and immediate surroundings.

In considering the general subject of safeguarding, we are impressed with the belief that it should be a part of general education to learn to avoid dangerous situations. The apprentice should be taught that all moving machinery is dangerous. While he must acquire familiarity with it and be ready to do his work in situations that perhaps would be dangerous to the amateur, he must not feel contempt for the elements of danger. His attitude toward a moving machine should be much the same as toward an open flame, steam pipes or electric wires. He can use the fire, the steam, or the electricity safely when properly directed, but when wrongly directed it is likely to do him bodily harm. Another thought is that he should be taught that it is discreditable to get hurt, and doubly discreditable to hurt someone else. To neglect reporting dangerous conditions makes the persons having knowledge of them morally responsible.

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THE PNEUMATIC TIRE

The invention of the pneumatic tire by Dunlop effected the greatest improvement in road vehicles since the advent of springs. The bicycle was not a popular machine until it was provided with pneumatic tires, these converting it from a "boneshaker" to a comfortable vehicle that old and young could ride with pleasure. The pneumatic tire is one of the chief factors in the success of the motorcycle and automobile, but unfortunately is their most serious weakness.

No invention is more greatly needed to-day than a puncture-proof pneumatic tire that will be resilient as well as reliable. Numerous pneumatic tires have been made puncture-proof, or practically so, but only at the expense of resiliency. The high speeds at which the motor cars are driven make highly resilient tires absolutely essential, and the history of spring wheels and cushion tires does not seem to indicate that any acceptable substitute for the air cushion will be found. The millionth patent recently granted by the United States to an Ohio inventor was for a puncture-proof tire, but unfortunately it belongs to a class of tire inventions which have been much exploited but very unprofitable to users.

The Westinghouse air cylinders may be a practical solution of the problem, the pneumatic cushion being transferred from the wheel to cylinders which take the place of the usual leaf spring. A weakness of this form is that the wheels are fitted with solid rubber tires which are practically unyielding and must, therefore, surmount every obstacle in the road. The efficiency of the pneumatic tire is partially due to the fact that its surface is yielding. Small obstacles are thus embraced, and not surmounted, as must be the case with all solid tires.

THE PREVENTION OF INDUSTRIAL ACCIDENTS*

In the Bulletin of the Bureau of Labor, No. 78, for September, 1908, Frederick L. Hoffman, writing on industrial accidents, says: "Upon a conservative estimate, the total mortality from accidents in the United States among adult male wage earners is between 30,000 and 35,000, of which it should not be impossible to save about one-third and, perhaps, one-half, by intelligent and rational methods of factory inspection, legislation and control. In addition there were approximately not much less than two million non-fatal accidents, that not only involve a vast amount of human suffering and sorrow, but materially curtail the normal longevity among those exposed to the often needless risk of industrial casualties."

We do not have in the United States complete records showing the probable percentage of accidents which could be avoided if proper measures were taken, but we can make a fair estimate by comparison with other countries where accident statistics are available, and also by quoting such statistics as have been compiled in this country by individuals whose work has been devoted to the prevention of accidents in industrial plants. In Germany, where excellent precautions for preventing industrial accidents are taken, about fifty-eight per cent of the accidents are due to negligence of employer or employe, while forty-two per cent may be regarded as the inevitable risks of employment. In other words, more than one-half of all accidents could probably even there be avoided if both employer and employe would use the utmost care and vigilance.

In the United States in one plant where the yearly average was 200 accidents, the result of greater attention given to preventive measures reduced the number of accidents during the past year to sixty-four, and of these accidents only thirty-eight were of a character to be considered as wholly non-preventable or accidental in the most literal sense of the word. Compared with the previous yearly average of 200 accidents, this would indicate that in the average American shop only about twenty per cent of the accidents belong in the non-preventable class, while possibly about eighty per cent and certainly at least seventy per cent could be eliminated if greater attention were paid to safeguarding the machinery, instructing the employes, and in other ways removing the possibilities of accidents. The estimate above is based on actual results obtained in one plant in the United States as stated by Mr. John Calder in a paper read before the American Society of Mechanical Engineers, February 14, 1911.

That there is a crying need for paying more attention to this subject, and that more concentrated efforts for the prevention of accidents should be made, is, therefore, beyond question. Aside from the humanitarian aspect of the matter, the financial loss alone due to accidents is so great as to warrant the most complete precautions for their prevention.

Causes of Accidents

Mr. Calder, in the paper previously referred to, attributes industrial accidents to the following principal causes: Ignorance, carelessness, unsuitable clothing, inefficient lighting, dirty and obstructed work places, defects of machinery and structures, and the absence of safeguards. To these may be added lack of good air—this on account of the stupifying effect of impure air on the mind. Until recently little regard has been paid to the causes underlying accidents, except

* The following information relating to this and kindred subjects has previously been published in MACHINERY: "American Museum of Safety Granted a Charter," June, 1911; "Industrial Safety Association," April, 1911, engineering edition; "The Mechanical Engineer and Prevention of Accidents," March, 1911, engineering edition; "Industrial Accidents and Employers' Liability," December, 1910, engineering edition; "The Cost of Accidents in the Industries," September, 1910, engineering edition; "Don'ts for the Prevention of Accidents in the Machine Shop," July, 1910; "When to Safeguard Machinery," February, 1910, engineering edition; "Practical Safeguards in the National Cash Register Company's Plant," January, 1910, engineering edition; "Progress in Safeguarding Machinery," November, 1909; "Safety Device for Electric Cranes," July, 1909; "Accident Prevention at the Plants of the United States Steel Corporation," February, 1909, engineering edition; "Prevention of Accidents in the Foundry," November, 1908; "Safety Device for Buzz-planers," November, 1908; "Liability to Accident at Different Ages," July, 1908; "Exposition of Safety Devices," May, 1908; "Liability of Employers," December, 1907, engineering edition; "Safeguard in Machinery," December, 1907; "Liability of Employers," November, 1907, engineering edition; "Visit to he Exposition of Safety Appliances," March, 1907; "An Exposition of Safety Devices," October, 1906.

to the absence of safeguards, but any well-considered action for the prevention of accidents must be based solely on a study of the causes. A complete review of the causes of accidents, as enumerated in Mr. Calder's paper, was given in the March, 1911, number of MACHINERY, engineering edition.

It is often assumed that with advancing age the liability to accidents increases. According to a compilation by Sir John Brunner, first published in the London *Times*, and covering an investigation extending over fifteen years, this assumption is erroneous. The percentage of accidents per year to men between eighteen and twenty-five years of age is almost four times as great as that to men of fifty-six years or more, and there is an almost regular decline in the percentage of accidents with advancing age, from eighteen to fifty-six years.

The liability to accidents has also some relation to sex. Women are more liable to such accidents as are caused by their clothing and their hair being caught in machinery. Incidentally it may be mentioned that the danger of women's hair being caught in machinery can be effectively safeguarded against by the wearing of close-fitting caps completely covering the hair.

Prevention of Accidents and its Relation to Machine Design

The relation of the design of machinery to the prevention of accidents is of especial interest to the readers of MACHINERY. We have on several occasions in the past made editorial comment on this subject. Safety of operation should be placed on a par with mechanical efficiency, and all the required safeguards should be provided on the machines at the time when they are designed and constructed. It is very difficult to provide effective safety devices on machinery that has not been originally designed for them. The designers can cheaply and effectively provide guards in the original design of the machine. These guards can be so designed that they will not only constitute a valuable selling point, but will add to the pleasing appearance of the machine as well. On a machine built without safeguards, it is sometimes almost impossible to provide effective guards for gearing and other dangerous moving parts, because of lack of clearance, whereas in the original design suitable guards could have been provided without appreciable cost, and without perceptible change in the design.

As pointed out in an editorial in the November, 1909, number of MACHINERY, purchasers of machine tools can materially accelerate the movement for the safeguarding of industrial workers by insisting on efficient guards on all new machines. The negligible additional cost of machines provided with efficient guards is made up for many times by the greater freedom from accidents with the consequent decrease of liability on the part of the employer, and the elimination of compensation payments or law-suits.

A very important point in the designing of safeguards is to make them of such a character that there will be no temptation on the part of the workman to remove the guards, and leave them off permanently. The guards must not be cumbersome in any way, they must not make the operation of the machine any more difficult, and they must not reduce production. This last requirement is one in which both employer and employe are equally interested. The former will have a tendency to begrudge the introduction of safety appliances, if he suspects that they interfere with rapid production. The worker, again, if he be a piece-worker, is as anxious to turn out a good day's work as the manufacturer, and if he is hampered in this, he will discard the safeguard at the first opportunity. The designer must, therefore, make a careful inquiry into the conditions under which an employe has to work, so that he can devise safety appliances which enable the worker to proceed with the same efficiency with or without the safeguard.

Compensation in Cases of Accident

Closely allied with the subject of the prevention of accidents is that of the payment of compensation to the victims of industrial casualties. This is a matter that is still handled in a very unsatisfactory manner in the United States. In most of the industrial countries in Europe, the question of compensation in cases of accidents is taken care of by definite laws, which are working to satisfaction. It is generally believed that such laws involve undue expense to the employer, but the experience of Great Britain seems to disprove this theory. In the October 28, 1910, number of the *Practical Engineer*, London, it was stated that the average annual expense per capita in the metal trades in England for efficient system of insurance against accident, has been estimated at about one-half cent per day. It is also stated that a satisfactory feature of the working of the laws in Great Britain has been to increase the number of compensation disputes settled out of court, thus saving the expense of litigation and avoiding delay.

It is evident that it is the industry as a whole and not the individual employer that will bear the expense, but it is necessary in any well-ordered community to have what might be called an "automatically" working law of compensation, providing for those who are injured in the performance of their duty. In this connection it is of interest to again quote the opinion stated by Mr. W. B. Dickson, first vice-president of the United States Steel Corporation, to which we referred in the December, 1910, number of MACHINERY. In a paper read before the American Iron and Steel Institute, Mr. Dickson said: "Personally, I believe that compensation to injured workmen is a legitimate charge against the cost of manufacture, and that the victim of an industrial accident, or his dependents, should receive compensation, not as an act of grace on the part of his employer, but as a right."

The figure of one-half cent per day per employe would, of course, be somewhat higher in the United States owing to the generally higher level of prices and the consequent higher rate of compensation required; but on the same basis as the British liability laws, one cent per day per employe should usually cover the employer's expense for the required insurance. Figures compiled in this country by the Fidelity & Casualty Co., of New York, covering the years from 1893 to 1900, at a time when much less attention was paid to the safeguarding of industrial workers than is now done, indicate that for one-hundred dollars of wages paid, the average loss due to employer's liability was about 36 cents. This would average somewhat less than one cent per day per employe.

These are then the two main questions that confront the industries to-day with regard to the safety of the worker—the prevention of accidents, as far as it is possible, and a fair system of compensation to be paid to the victims of such industrial accidents as cannot be avoided.

That the importance of these two questions is fully appreciated by the employers in the United States at this time is well evidenced by a resolution adopted on the strength of an inquiry among several thousand employers of the United States. Mr. Ferdinand C. Schwedtman, in a paper presented to the National Machine Tool Builders' Association at Atlantic City, New Jersey, in May, 1911, quoted a resolution adopted at the annual meeting of the National Association of Manufacturers, as follows:

"Be it resolved, that the present system of determining employers' liability is unsatisfactory, wasteful, slow in operation, and antagonistic to harmonious relations between employers and wage-workers; that an equitable, mutually contributory indemnity system, automatically providing relief for victims of industrial accidents and their dependents, is required to reduce waste, litigation and friction, and to meet the demands of an enlightened nation.

"Be it further resolved, that prevention of accidents is of even greater importance than equitable compensation to injured workers."

This resolution conveys the attitude of probably ninety-nine out of one hundred employers.

History of the Movement for the Prevention of Accidents in the United States

Up to about five years ago the efforts for the prevention of accidents were unorganized and spasmodic. The safeguarding of machinery was looked upon as a kind of philanthropy rather than as a duty. It is significant that it was chiefly in cases where property as well as persons were liable to injury that preventive measures against accident were generally and effectively undertaken. The absence of safety devices has been almost entirely due to lack of interest on the part of the employer. Men in secondary positions of authority have often refrained from exercising all possible precautions for safety for the reason that these involve additional expense of which the management might not approve,

or at least because they realized that they would get no credit from the men higher up for taking precautions. This condition is now slowly changing. It is desirable that foremen and sub-foremen should be encouraged to see that all precautions for the safety of the employes are taken. In most industrial plants the enforcement of the rules relating to safeguarding will be part of the duties of these men.

The first organized effort in this country might be said to have been made by the American Society of Social Service, which held, from January 28 to February 9, 1907, an exposition of safety devices for protecting the lives of workmen and of devices pertaining to industrial hygiene, care of health, and safety of the general public. This exposition was the first of its kind in the United States, although as far back as 1889, similar expositions were held in Germany and in the next following years in Vienna, Amsterdam and other European cities. The leading spirit in the new undertaking was Dr. William H. Tolman. In 1908 a second exposition was held from May 13 until June 1. At this time many exhibits of special interest to machine tool builders were shown, in particular some selections of large photographs from the Brown & Sharpe Mfg. Co., and from the various plants of the Niles-Bement-Pond Co., showing installations for safeguarding the workmen in these establishments, as well as machines built by these companies provided with proper guards over gearing, emery wheels, etc.

During the past year the organized efforts have been still further increased. An association organized under the name of the Industrial Safety Association has been formed, which is closely associated with the body known by the name of the American Museum of Safety, which latter has been granted a special charter of incorporation by the legislature of the state of New York. Of this association Dr. F. R. Hutton is the president. A detailed statement of the objects of the association and its plans of work was given in the April, 1911, number of MACHINERY, engineering edition.

Another indication of the attention that is being paid to this important subject is that the accident insurance companies are taking active steps to collect and distribute such information relating to the practical prevention of accidents as is available. At least two of the leading insurance companies have published important additions to the literature relating to the prevention of accidents.*

MACHINERY has taken an active part in the work for the prevention of industrial accidents since the very inception of the movement. A great number of editorials and other articles have been published urging manufacturers and machine designers to give proper attention to this important subject, and we believe that the wide publicity thus given to the organized efforts made has materially aided the advance of the movement. The editor of MACHINERY, Mr. Fred E. Rogers, has been a member of the committee of the American Museum of Safety from the beginning, and is one of the charter members of the incorporated association. In order to further extend the useful work that MACHINERY has been doing along the lines of the prevention of accidents to industrial workers, a study of the means for the prevention of accidents in the machine shop has been undertaken and contributions on this subject have been requested from engineers and mechanics in this country and abroad. The most important contributions on the subject are published in the following pages, where many valuable hints for the workers themselves as well as for those responsible for the safe working of factories or other industrial undertakings will be found. Many of the recommendations that are made can be adopted without very great expense, and in some cases where local conditions may be such that the expense would be considerable, it will be found that proper safeguarding will pay for itself in the long run. Should it be found, in older installations, that some of the methods recommended are too expensive for adoption, it should at least be remembered that whenever new machinery is built or additions to the plant considered, the new construction should be provided with the proper safeguards.

* "Safeguards for the Prevention of Industrial Accidents," published by the Aetna Life Insurance Company, Hartford, Conn., price $0.50; and "The Prevention of Industrial Accidents," published by The Fidelity and Casualty Company of New York, price $0.25.

SAFETY DEVICES AS APPLIED TO MACHINE TOOLS*

By CLARENCE BOLTON†

In the following article a number of simple guards and safety devices which can be applied to machine tools without incurring any great expense are illustrated. Most of these require but little description, and are intended merely to aid the designer by giving him an idea of the type of guard or device to be used. Obviously, the suggestions given may not apply directly to any specific case, but the principle involved can easily be adapted to the different requirements in individual shops. Figs. 1 to 5 shows types of covers ordinarily

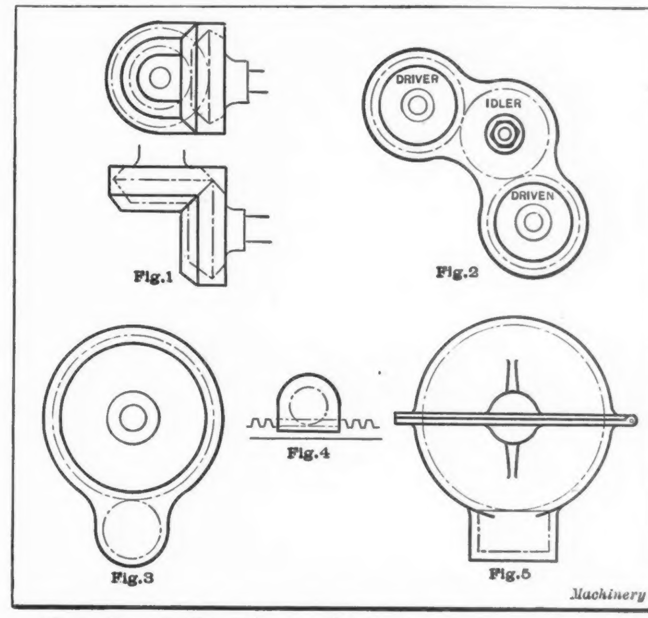
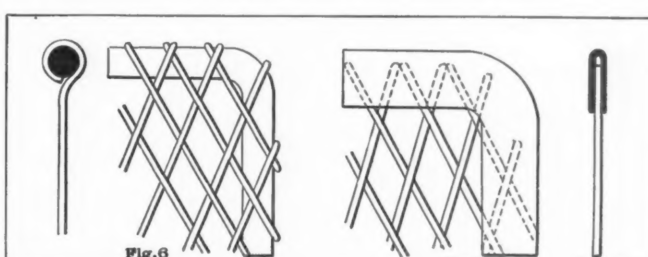


Fig. 1. Cover for Bevel Gears. Fig. 2. Cover for Train of Spur Gears. Fig. 3. Cover for Spur Gear and Pinion. Fig. 4. Cover for Rack and Pinion. Fig. 5. Cover for Worm-drive

applied to gearing. In general, the shape of the cover takes, as nearly as possible, the form of the outline of the gear. The method of supporting the cover will depend entirely on the circumstances. In Fig. 2, for example, the cover for the three gears shown is supported by the stud of the idler gear, as indicated.

The covers for gearing present the neatest appearance, and are undoubtedly strongest, when made of cast iron. In some



Figs. 6 and 7. Methods of Attaching Wire-mesh Guards to Frames

cases, however, they would be too costly and massive if made of this material, and then sheet-iron or wire-mesh guards can be used. Types of guards of this kind are shown in Figs. 6 to 11, inclusive. In the guard shown in Fig. 6, a strong wire frame is used for supporting the wire mesh. In Fig. 7 a sheet-iron frame is used as the support, being bent over the ends of the wires. In Fig. 8 a sheet-iron guard is used, reinforced by a strong wire frame. In Fig. 9 the reinforcement or stiffening of the sheet-iron plate is obtained by pressing a rib into the sheet iron. In Fig. 10 a sheet-steel frame is employed to which the wire mesh is attached, and this frame, in turn, is strengthened by a wire about which the sheet steel is coiled. In Fig. 11 is shown an angle-iron frame supporting the wire mesh.

Whenever it is possible to provide a door in covers over

* For information previously published on safety devices, see MACHINERY, January, 1910, "Practical Safeguards in the National Cash Register Co.'s Plant."

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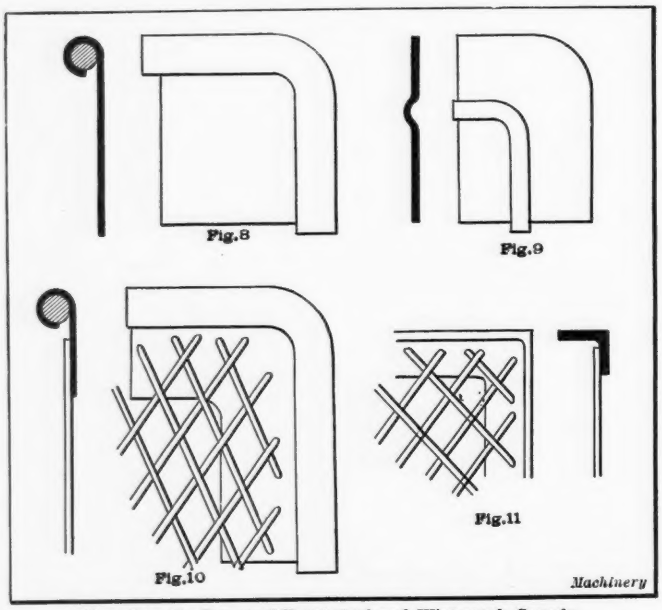
parts to which it is necessary to have access, this should be done. There are various methods for applying doors to machine frames and covers. The simplest method of arranging a door is shown in Fig. 12. This door is opened by raising it by the handle sufficiently to permit it to open. The required amount of play is left at the hinges to compensate for this movement. In Fig. 13 is indicated a type of hinge cast in a spiral shape. This is known as the "rising hinge," and it



Figs. 8 to 11. Types of Sheet-steel and Wire-mesh Guards

always returns the door automatically to a closed position, thus preventing accidents which might occur by the door being left open.

As far as possible there should be no projections on the surface of covers, frames, etc. In the case of doors and covers, these should be as level and flush with the surrounding surface as possible. Safety set-screws should be used wher-

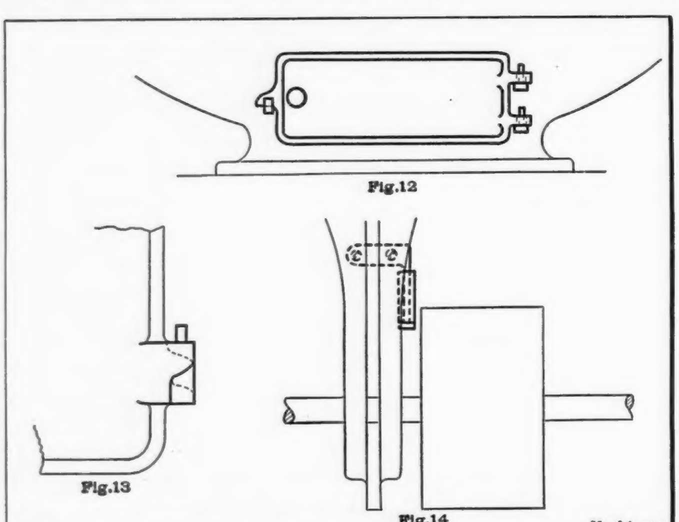


Fig. 12. Ordinary Type of Door used on Covers or Machinery Frames. Fig. 13. "Rising Hinge" used for automatically Closing Door. Fig. 14. Guard for Preventing Belt from Slipping in between Pulley and Hanger

ever feasible. Rotating parts, such as chucks, that cannot conveniently be covered with a guard, should always be fitted with safety set-screws.

When tapping castings, the tap is likely to stick in the casting and force it to rotate, sometimes causing injury to the hands. An arrangement for preventing this is shown in Fig. 16. The device shown is an adjustable support. The two standards *A* support two arms *B* which are adjustable on the standards. The clamping device is made of two strips *C* and *D*, holding the casting while it is being tapped. These strips slide back and forth on arms *B*.

The device shown in Fig. 14 prevents the belt from slipping into the narrow space between the pulley and the hanger. This device consists simply of a bracket screwed to the hanger and carrying a guard which regulates the position of the belt. Wide belts running over machines are very dangerous. A cheap and effective guard is shown in Fig. 15. Here a sheet-steel cover is supported from the ceiling and encases the pulley, while a board guards the remainder of the drive as indicated. A safe and satisfactory system of driving polishing wheels from below is shown in Fig. 17. This is especially suitable where boys are employed. This drive obviates all belt risks, and at the same time permits the belts to be inspected much better than when the drive is overhead.

The following illustrations show some special machine-tool guards. The punch press undoubtedly is one of the most dangerous tools around the machine shop. It is very seldom efficiently guarded, although many simple methods can be adopted. The guarding of the space between the punch and die is, of course, of prime importance. A couple of brackets screwed to the frame and supporting a sheet-iron plate with

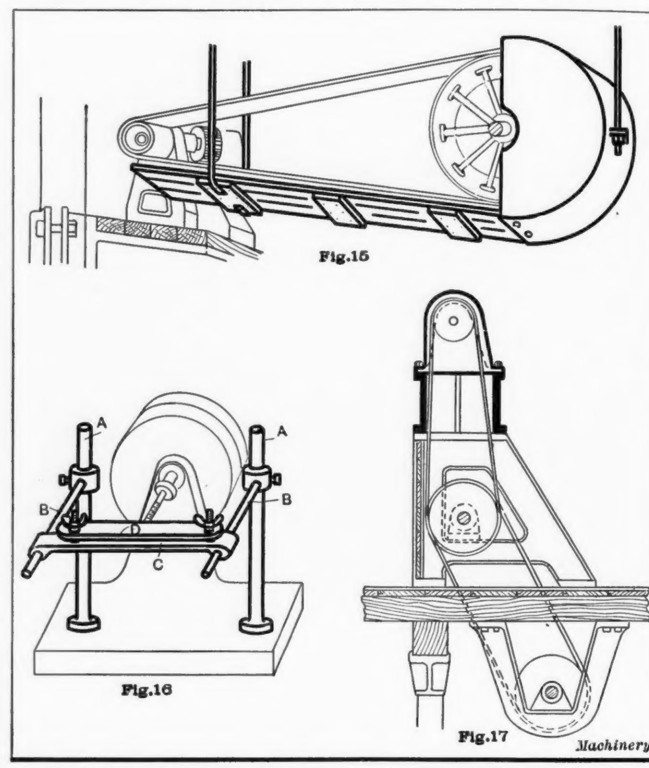


Fig. 15. Guard for Overhead Drive with Wide Heavy Belt. Fig. 16. Holder for Preventing Rotation of Castings when Tapping. Fig. 17. Safe Method of Driving Polishing Heads from beneath

an aperture on the under side, large enough to push the stock through, is simple and yet very effective. A guard of this type is indicated in Fig. 18. Movable guards, such as plates with a horizontal reciprocating motion, timed to push the

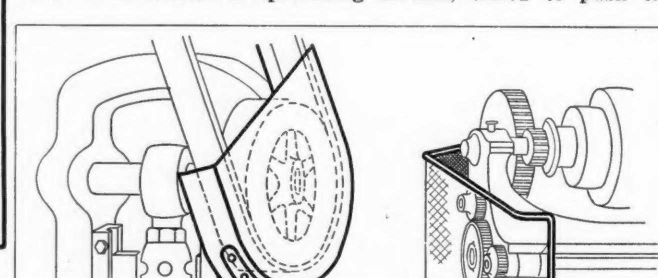


Fig. 18. Guards for Punch Press Fig. 19. Guards for Change Gears

fingers away, or guards provided with a vertical motion and descending upon the hand previous to the cutting action, are also used. The flywheel and driving belt should also be guarded, as they have caused many accidents. A simple method of providing a cover for them is also indicated in Fig. 18.

In the case of change gearing on a lathe, cast-iron covers cannot always be used to advantage, but a guard made of wire mesh, as shown in Fig. 19, is very useful. The milling cutter guard shown in Fig. 20 was originally patented by Messrs. Alfred Herbert, Ltd., Coventry, England. It has been found quite satisfactory and has been approved by the official inspectors of factories in Great Britain. The firm owning the patent has, however, withdrawn its rights, so that this guard can be freely used by the public. In Fig. 21 is shown an emery-wheel gear-tooth grinder provided with a cover. This cover has a loose side or door fastened by thumb-screws and hinges. In this way the removal of old wheels and the mounting of new ones can be done without removing the guard proper.

A cover for a cold saw is shown in Fig. 22. The cover is screwed onto the handle which supports the saw, and thus prevents the hand from coming in contact with the saw or

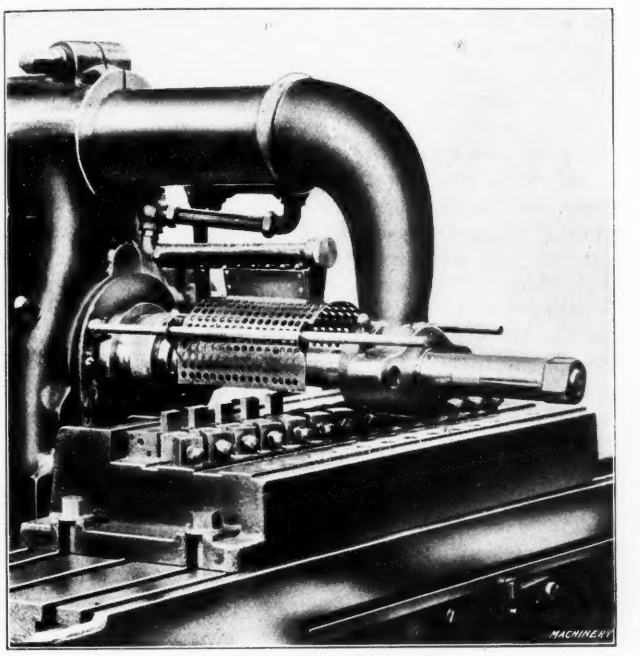


Fig. 20. Milling Cutter Guard

getting trapped in the chain. Covers for ordinary emery grinders are very numerous. One of the simplest types is shown in Fig. 23. This cover has the advantage of being adjustable as regards its height and position. It is made of a steel stamping with a nut and bolt support.

Exposed driving pulleys and speed cones of a drilling machine are extremely dangerous, especially when a man has to work behind them or when they face toward a passage. In

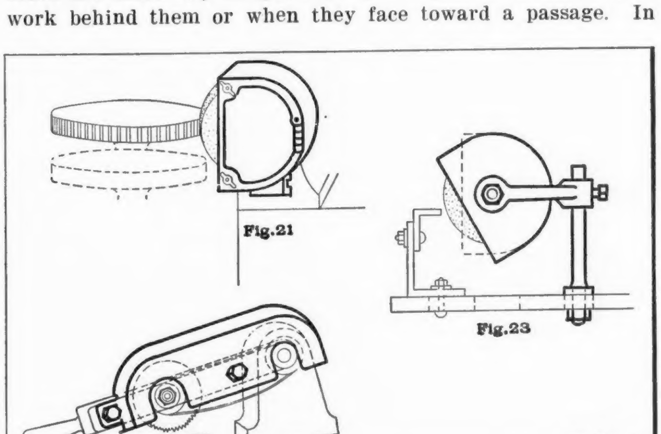


Fig. 21. Cover for Emery Wheel. Fig. 22. Cover for Cold Saw and Chain. Fig. 23. Adjustable Emery-wheel Cover

Fig. 24 is shown a method of encasing them with a cage having an angle-iron framing. A door is provided to facilitate the changing of speeds.

General Rules for Avoiding Accidents in the Machine Shop

Precautions which may be taken to avoid accidents have been reiterated so many times that it seems hardly worth while to repeat them. There are a few rules, however, which, it seems, cannot be stated too often. Every mechanic knows that the loose pulley should be kept well lubricated, as many accidents have occurred through the loose pulley sticking to the revolving shaft and unexpectedly starting the machine. Another precaution to take is never to ascend a ladder over a machine unless it is provided with floor spikes or shaft hooks. Emery wheels cause a great deal of trouble and many accidents are due solely to lack of understanding and carelessness. Do not bear too hard on an emery wheel. You will

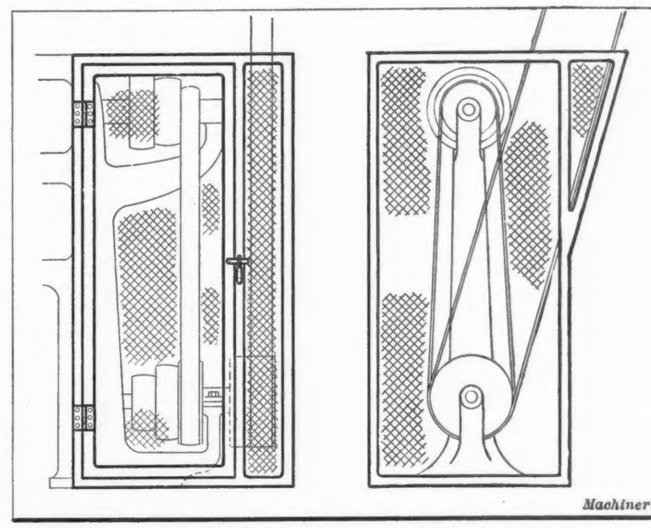


Fig. 24. Guard for the Driving Pulleys of a Vertical Drilling Machine

not remove more metal by doing so, and the wheel will simply be clogged and glazed, and have a tendency to break. It is an unwise saving of time to be afraid to take sufficient pains to see that an emery wheel is properly secured. No one should ever be required to work at a dry polishing lathe or emery grinder which is not provided with dusthoods and efficient suction for preventing the dust from filling the room. The dangers due to breathing the impure air in a grinding room not provided with an efficient suction system are greater, in many respects, than those due to smaller accidents from which the victim may soon recover. A man may never recover from the injuries caused by the grinding dust constantly entering his lungs.

* * *

The recent breaking of a large reinforced concrete dam which released a flood of water that wiped out the town of Austin, Pa., calls the attention of the engineering world to the uncertainty of concrete construction on the one hand and a serious defect of the common form of masonry or concrete dam on the other. To insure the soundness of concrete structures whose integrity depends on perfect homogeneity it seems that the work once started should continue day and night without cessation until completion. This, aside from the difficulty of securing perfect mixing and the best materials, makes the erection of souna monolithic concrete work no easy matter. The second trouble is due to water percolating into the strata beneath the dam foundation. The common form of masonry or concrete dam which resists displacement and overturning by reason of its sheer weight, is generally secure if water can be kept from beneath, but "there's the rub." The percolation of water under heavy pressure into many soils or even into some rocks is beyond the power of engineers to prevent. The greater the area of the base of a dam on a permeable foundation, the more likely it is to be displaced by the hydraulic pressure beneath it and against it. The old "bear-trap" dam built of logs, plank, brush and dirt was constructed on sound principles. The inclination of the dam face is at an angle that insures stability. The pressure of water normal to the face resolved into its vertical and horizontal components, yields a horizontal force less than the product of the vertical component and the coefficient of friction of soil or rock. No anchors are required and seepage cannot seriously affect its stability. But, unfortunately, the principle of this form of dam cannot be used where most needed because of the great cost entailed in building high dams.

ACCIDENTS IN THE MACHINE SHOP*

SUGGESTIONS AND RULES FOR THEIR PREVENTION, COLLECTED FROM VARIOUS SOURCES

The rules for the prevention of accidents in machine shops naturally divide themselves into two main classes—those which primarily concern the employer, and those which must be observed by the machine operator in his effort to guard himself against injury. The employer must provide the required safeguards; the employe must use care in operating his machines without taking unnecessary chances. In the following, the rules and suggestions given are classified, in the first place, with regard to these two main classes. It must be remembered, however, that there can be no hard and fast line drawn between the duties of the employer and those of the employe in the prevention of industrial accidents; a spirit of cooperation should always be present. The rules are further classified with regard to the specific subject to which they pertain—arrangement of machines, operation, etc.

1. SUGGESTIONS AND RULES FOR THE SHOP MANAGEMENT

The first thing to do in the prevention of accidents is to get a clear idea of the particular dangers that need to be guarded against. The arrangement and erection of machine tools comes first in order, as it determines the conditions under which the operator works and has much to do with his safety. The particular dangers met with must then be taken care of; these include the risks arising from projecting keys and set-screws, unguarded gears and belts, dangerous position of machines, as for instance, a planer placed so that at full stroke it might crush anyone who passed between it and a wall or bench. Bearings must be so placed that to oil them does not involve a risk, etc.

Instructing Employes

A very important consideration is that of the instruction of employes in regard to the dangers against which they must be on their guard. Apprentices in machine shops should especially be given better supervision than is now the case, and they should be systematically and thoroughly instructed as regards the dangers of machinery. But in addition, all employes, especially new employes, must be carefully instructed in the language they understand, regarding the work they are to do, and particularly regarding possible dangers of the employment. The dangerous parts of the machinery about which they must work must be pointed out to them, and they must be cautioned about the same.

When printed rules are used, each foreman must make it his business to know that every employe has read the rules, and understands them, and is familiar with the danger of his work. If an employe is changed to other employment, the same care with regard to instruction must be used. No employe must be allowed to remain in a department who cannot be made to fully understand the instructions.

In many cases, an important part of the instruction given is to show the men how to place themselves so that they can move out of danger if anything should slip or break.

There are certain employes who, through stupidity or carelessness, are frequently injured. Such employes should be put on a job where they cannot get hurt. Slow-thinking and ignorant men should not be put on jobs where it requires a quick, bright man. A large number of accidents are caused through ignorance or lack of intelligence on the part of workmen.

Arrangement of Shop and Machinery

In many shops the men have to spend much of their time looking out for their own safety. If the management, therefore, wishes to increase the efficiency of such shops, it must arrange the machines and place the equipment in such shape that the workmen can work in safety, and not have to waste their time in self-protection.

Cleanliness, fresh air, warmth, and good ventilation, with a few other humane thoughts for the benefit of the workingman, will assist in keeping the number of accidents down to a minimum, as the average workman will be far more careful, and will produce better work, in a shop where he feels that some care and thought is given to the conditions under which he works.

Plenty of light, natural or artificial, should be provided around each machine, and in all stairways and passageways. Statistics show that light has a very important place in protection—darkness is always dangerous. The light in a shop may be greatly increased by keeping the electric globes clean and the windows washed. If workmen cannot see, they must feel, and it is this that costs so many fingers and sometimes lives. Clean windows and floors and whitewashed ceilings and walls (and even machines painted white) would prevent many accidents.

Economy of floor space, while important, can be carried too far. Ample room should be provided around each machine for the free movement of the operator and his work.

The traversing carriage or table of any machine should not be allowed to run out within a distance of less than eighteen inches from any fixed structure not being a part of the machine, if the space over which it runs is a space over which any person is liable to pass, whether in the course of his employment or otherwise. A planer, for example, should never be placed so that the platen, under any circumstances, could crush a man between it and a wall, post or other fixed object. Nor should a planer be so set that the platen will need to travel over a gangway, especially if the gangway is used for moving trucks or heavy castings or forgings along it. Someone may be easily crushed between the platen and the object moved along the gangway.

When drop hammers are located near an aisle where persons pass along to the rear of the hammer, a shield must be provided to stop flying scales.

Where necessary, there should be sufficient room for the operator to pass right round his machine without endangering his person by coming into contact with belts, gears, etc.

All benches in the shop should be so arranged that there will be no danger of the workman being jammed between his work or the bench and moving parts of machinery, cranes, shop cars, or trucks.

Heavy machines should not be placed on light platforms or galleries.

All passageways and gangways should be kept smooth and in good repair, and free from all obstructions over which the men may stumble and fall. The foreman should constantly watch the passageways and see that they do not become crowded. All passageways where men must pass in the regular course of their work must be sufficiently wide to insure safety.

Turnings and metal chips should not be allowed to accumulate in any part of a machine shop, especially not in the vicinity of machine tools.

The floor of the shop should not be littered up with defective and discarded castings. Finished work and jigs not in use should be removed promptly.

The floors of the shops should be kept in good condition. Tracks for shop truck or railway tracks should not project above the surface of the floor.

Oiling of Shafting and Shafting Guards

All machines and shafting (line and counter) should be periodically and systematically oiled, the frequency of oiling depending upon the extent to which the machine and shafting are used and their duty. The oiling of shafting must be done by special men, who must be required to wear tight-fitting clothing, and use long-stemmed oil-cans where possible. Where practicable, oiling should be done when the power is off. The ladders used by oilers must be equipped with steel points at the bottom. A ladder must not be allowed to lean against shafting which is in motion if it is possible to avoid so doing. Where a lineshaft is close to a wall, a workman must never place a ladder against the wall and thus put himself between

* In the preparation of the following collection of suggestions and rules for the prevention of accidents in the machine shop, use has been made of material contributed by V. Brockbank, Handsworth, England; J. E. Cooley, Hartford, Conn.; James H. Carver, Schenectady, N. Y.; George W. Burley, Sheffield, England; H. S. Busey, Baltimore, Md.; B. Bendix, Pittsburg, Pa.; Jos. M. Burnett, Windsor, Conn.; T. S. Bentley, Ilford, England; S. Victor Brook, Middletown, Conn.; J. E. Andrew, Bristol, Conn.; A. G. Bennett, Philadelphia, Pa.; F. J. Badge, Brooklyn, N. Y.; G. W. Akerlow, Bridgeport, Conn.; Martin H. Ball, Watervliet, N. Y.; William F. Arzinger, Jersey City, N. J.; W. B. Bolles, Tacoma, Wash.; Wm. Chas. Betz, New Britain, Conn.; Wm. H. Addis, Springfield, Ill.; J. D. Chambers, Tacoma, Wash.; A. L. Campbell, Detroit, Mich.; F. W. Brady, Scranton, Pa.; H. B. Cohstock, St. Paul, Minn.; Wm. W. Cowles, Poughkeepsie, N. Y. Use has also been made of collections of rules and regulations published by the Illinois Steel Co., and the International Harvester Co.

the shafting and the wall. Working in a cramped space like this, close to a rapidly revolving shaft, is always dangerous.

Shafting within twelve inches of the floor should be encased. Shafting higher than twelve inches and not more than seven feet from the floor should be railed off or otherwise guarded. The ends of shafting, where exposed to contact, should be protected.

Countershafts should not be placed directly over the operator, but should be placed back of the machine. All overhead hanger-bolts should be inspected frequently.

All pulleys, collars, etc., should be examined periodically for security of holding, while the former should also be examined for truth of running. Any defects should be remedied at the time of discovery.

Stairs and Railings, etc.

Stairs should not be built at a sharper angle than 50 degrees. When an angle over 50 degrees is required, ladders should be used instead. The sum of the riser and tread should equal about 17½ inches. All stairways must be equipped with handrails, and the rails must be kept smooth and free from nails and splinters.

Railings should be at least three feet six inches high. Pipe railing should be made of not less than 1¼-inch pipe. Angle railing should be made of not less than 2 x 2 x ¼-inch angle iron. All railings ten feet above the floor should be made of metal, and should have a toe-board at their base. Angle-posts should be chamfered.

Counterweights on doors or machines should be so situated or guarded that they cannot fall on anyone should something break. Door counterweights should be boxed in.

Where a machine is located so that the operator must stand near a swinging door, a stop must be so placed as to prevent the door from striking him.

All swinging doors should be equipped with windows, properly guarded, and of sufficient size to make it easy to see a man approaching from the opposite side. A size of window which has been found adequate is 8 x 24 inches, with one window provided for each of the two swinging doors. Both sides of the door must be provided with light, either natural or artificial. The windows must be kept clean.

Avoid hinged skylight windows, as the danger due to falling glass has often been demonstrated.

All portable ladders, where practicable, should be equipped with metal points or spurs at the bottom, and with hooks at the top.

Safeguards for Machines

All moving machine parts, where dangerous and where exposed to contact, must be properly guarded, and all projections of any nature on moving parts, where exposed to contact, must be properly protected.

Collars used on shafting should have safety flanges high enough so that the head of the set-screws will not project above the flange. All set-screws should be placed in safety collars, countersunk, or covered by a guard.

Set-screws with heads projecting from the moving parts of a machine should be replaced with headless or socket set-screws, when no other protection is provided.

Chucks or other revolving parts with projecting screw heads should be avoided wherever possible.

Exposed holes and recesses in rapidly rotating parts of a machine should be plugged or covered. If necessary, means can be provided for removing the plugs or covers.

All screws and bolts on parts which have to be reversed frequently should have locking nuts placed on them to prevent their slacking back and falling out; or, in place of these, some other effective method of fixing and locking them in position should be resorted to.

Lead-screws placed in the front of the lathe should not have a spline cut in them. Men standing close to the machine often have their overalls wound up on the lead-screws and are in danger of injury.

All gears and gearing should be either enclosed or guarded wherever possible. In cases where it is necessary to remove the gear guards for the purpose of changing the gears, the guards should be replaced immediately after the gear-changing operation and before the machine is set in motion.

Handles on the ends of feed-screws and shafts should, preferably, be of the loose type, connected to the screw or shaft by means of a claw clutch or similar means, so that the handle can, when not in action, be slid off the screw or shaft. This prevents any accidental movement of the handle by the operator.

Power-feed to milling machines should be obtained through the medium of the main driving spindle, or, if obtained independently from the countershaft or feed motor, provision should be made whereby the feed will be stopped at the instant that the cutter ceases to rotate.

Wherever practicable, cutters in a milling machine should be provided with guards. This is seldom done in America and is considered impracticable by many, but in England where it is used to a considerable extent it has not been found to involve serious drawbacks.

Guide ways should be provided for the counterweights on boring mills.

Shapers and boring mills should be provided with a brake in addition to the ordinary shifter, so as to make it possible to stop them quickly.

Drilling machines, especially where girls are the operators, should be well protected from revolving spindle parts, as there is a possibility of entangling the hair when the operator leans over toward the work.

Emery or abrasive wheels over five inches in diameter should be provided with metal guards.

Emery wheels over eight inches in diameter should have a safety taper of three-fourths inch to the foot, should be equipped with safety collars, and with substantial tool rests.

All cup wheels should be guarded.

Emery wheels which are used almost continually should have a guard over the wheel connected to suction pipes, for the removal of dust. The dust is more dangerous than the more remote possibility of breakage.

For the shop print (mounted or unmounted), a hook or fixture should be placed in such a position that the operator can readily see it without leaning over the machine.

When repairing machine tools, changing dies, gears, etc., all power to the machines should be shut off and the belt thrown off, if possible.

When making overhead repairs, a sign which can be clearly seen from all sides should be placed on a stand about six feet high or suspended by wires at the same height. A good sign which can be clearly seen from all sides can be made of tin, triangular in shape, painted red and having the word "danger" in large letters.

Each punch press, stamping or cutting machine, or drop hammer, must be provided with a hook for removing the material from the dies of the machine.

All punches, hammers and other machines which are set in motion with a tripping device must be securely locked or blocked when not in use or when being adjusted or repaired.

All punch presses, where practicable, must be so shielded as to prevent the operator from putting his fingers under the punch when in motion.

Lights at machines should not be suspended by wires from the ceiling, but should be held in adjustable brackets or stands.

Where incandescent electric lamps are used, metallic reflectors, guards, and means for quickly adjusting the light to suit the work should always be provided. No makeshifts should be permitted.

The switch box of every motor driving a machine or group of machines should contain at least one extra fuse, for an emergency.

Where a group of machines is driven by an electric motor, the switch should be placed within easy reach of each machine. Before starting or stopping the motor timely notice should always be given.

Where electricity is used, all switches, transformers, fuses, motors, rheostats and controlling apparatus should be marked plainly with the voltage and amperage of the current passing through them when in operation. In addition, the word "danger" in large letters should be placed on any parts carrying over 200 volts, for while a shock of 200 volts may not be dangerous, it is generally quite disagreeable.

Belts and Pulleys

Belts and pulleys should be so located, wherever possible, as not to be dangerous to employes, or should be properly enclosed, fenced, or otherwise guarded. Belt and gear guards, covering belts and gears, are now being made extensively of sheet-metal, bent to suit conditions, made in box forms, and oxy-acetylene-welded at the angles. These, when painted, make very neat appearing guards. In place of the above, wire mesh or expanded metal is sometimes used, held at the edges or corners, by small rolled metal angles.

Bare pipe railing, used as a belt guard, is to be used only where the location of the belt is isolated—where there is but little traffic, and the probability of catching anything in the belt is remote. Wire netting should be made of wire not less than No. 12 gage, and not more than 1½-inch mesh. Steel casings should be made of not less than No. 10 gage plate.

In the lacing of belts the joints should be made close and smooth, and the laces or hooks should not be placed too near the edge of the belt. With high-speed machines it is best to make the belts endless. All hand-operated belts should be laced with raw-hide. Where practical, special men should be given the work of making, repairing, lacing and putting on all belts.

Whenever possible, belts should be placed overhead and as far away from working places as possible. Belts running in opposite directions should not be arranged in close proximity to each other.

All belts running through floors, or low, should be encased or guarded. All heavy, high-speed belts should be guarded.

Belts near female workers, where the hair is in danger of being caught by static electricity, should be guarded.

Belts should be examined periodically for joint efficiency and tension.

All loose pulleys must be furnished with a permanent belt shifter, so located as to be within easy reach of the operator. The loose pulley and the shifter must be so constructed as to make it impossible for the belt to creep from the loose pulley back onto the tight pulley. The belt shifter should not be placed where it can come in contact with the driving belt in any position. Sometimes the driving belt will touch the shifting lever when it is in the "off" position, and the lacing or joint will jerk the shifter and start the machine.

In putting on belts, the poles used in many shops certainly lessen the danger considerably. Pulleys on a main shaft should never be placed so close together that a belt if thrown off is liable to be caught between them. In crowded shops this is sometimes unavoidable, but it is seldom necessary to have the space on both sides of a pulley so limited that the belt cannot safely be thrown off. A guard should then be fixed to prevent the belt from coming off on the side which is cramped. As a general rule in placing pulleys on either the main- or counter-shafting, place them so that there is at least a space of one-and-one-half times the width of the belt between the pulleys. Be sure that all bushings are of the same length as the bushed pulley.

When two pulleys must be close together, or when a pulley is nearer to a hanger than the width of its belt, a hook should be so placed as to catch the belt, if it should run off, and prevent it dropping to the shaft or becoming wedged.

A good many countershafts are so arranged that they cannot be oiled without throwing the belt off, and this causes the oiling to be shirked. All loose pulleys should be designed so that they can be oiled without disturbing the belt.

Shifters on belt-driven tools, and controllers on motor-driven ones, should be within easy reach of the operator, if possible. See that there is plenty of clearance near the controller handle.

Cranes and Hoists

No person except the duly appointed operator should be allowed to operate a crane.

All cranes should have, in plain view, signs showing their capacity.

A substantial foot walk of steel construction throughout, provided with rough surface and located not less than 6 feet 6 inches below the roof truss, should extend the entire length of one or both bridge girders. Where the walk is on one girder only it should be on the driving side. This foot walk should have a railing at least 3 feet 6 inches high, and a guard or toe-board at least 6 inches high along the exposed edge of it, to prevent tools and other objects from falling off. There should be at least 18 inches clearance between the railing and the nearest part of the trolley, and on the driving side there should be at least 18 inches clearance between the railing and the shaft. The inside of this walk should be brought up against the bridge girder to prevent material falling between the walk and the girder. Where there is a foot walk on one bridge girder only, there should be a platform provided at one end of the bridge and opposite the foot walk, for use in inspecting and repairing the trolley. Where practicable, there should be a platform on the ends of the trolleys. The foot walk, where practicable, should be carried around instead of over the bridge motor.

The operator's cage should be made of steel and should be absolutely fireproof. A safe, convenient arrangement should be made for passing from the cage to the foot walk. Wherever possible, this should be within the cage proper, but if it is necessary to place a ladder for this purpose on the outside of the cage, an auxiliary platform—with railing and toe-board—should be provided to prevent anyone falling from the ladder to the ground. Where the cage is open, a toe-board at least six inches high should be provided around the floor of the cage.

Stairs and ladders on the buildings for the purpose of getting into the crane should, where practicable, terminate in a platform with regulation railing and toe-board.

A box, or other receptacle, should be placed on the cage or on the runway in which to keep oil cans, tools, etc.

All crane cables should be six strands, 37 wires, with hemp core for ordinary service, and iron core for cranes handling hot metal. Sheaves and drums should be not less than thirty times the diameter of the cable.

All chains should be made of wrought iron. In replacing links only those made of wrought iron should be used.

Only fully guaranteed, long fiber, manila rope should be used.

All slings used on hoists should, where practicable, be made of wire cable instead of chain, as cable gives warning of weakening by broken strands.

All hoists should be equipped with the best and especially approved wire rope. No chain ought to be used.

The drums should have flanges on each end not less than 1 inch thick, and should project at least 2¾ inches from the drum body.

All pneumatic lifts, blocks and tackles, small hand cranes, etc., when not in use, should be placed in such a position as not to interfere with the passages.

Elevators

All elevator doors should be of the automatic drop type, that is, they should close as soon as the platform leaves the floor.

The platform of an elevator should be entirely enclosed with wire panels, as should also the shaft.

The top of the shaft should be roofed with only a hole cut in it for the lifting rope, so that in case any parts should fall from the running gear, they cannot fall down the shaft.

2. RULES AND DON'TS FOR EMPLOYES

By far the greater proportion of accidents are caused by momentary thoughtlessness or carelessness. To avoid accidents, it is necessary that the workman concentrate his attention solely on his work. Try to cultivate a habit of always considering, before acting, what the result of any particular motion or operation will be. A man should learn to always keep in mind what would happen if "that timber should slip" or "that rope break." The most important is to teach yourself to use your own eyes and brain as regards your safety.

Many unnecessary risky things are done by many men simply because they have formed a careless habit. When lifting heavy pieces with crane, hoists or jacks, or in other ways, some workmen subject themselves to unnecessary risks by placing the hands or feet, and sometimes their whole body, where injury is sure to result if one of the parts bearing the load should slip or break. In cases where it is necessary for

men to work under parts suspended, blocking should be used for protection.

It is inadvisable to scuffle, fool, or play practical jokes in the shop. Many serious injuries have been caused by this practice.

Where there is not plenty of room between machines, one should not try to pass. To avoid danger, go where there is sufficient space to pass.

Operators of machine tools should, as far as it is possible and practicable, wear closely-fitting clothing, so that the risk of any revolving projection catching in any part of the operator's clothing and thus causing injury is reduced to a minimum. In particular, do not wear overalls with ragged sleeves.

Rules for Lathe Operators

Do not try to hold a drill and dog by hand, between centers, when the drill is over ¼ inch in diameter.

Do not put any other than a light-weight chuck, face-plate or special fixture on the lathe spindle, with the belt or controller "full on."

Keep clear of a fast-running lead-screw, if it has a keyway running along its length.

If you use a pneumatic hoist when taking out a piece of work held between centers, run the center nearly out, and carefully adjust the hoist before pulling the center entirely out. If the work is in the chuck, then, by aid of the tail-center, push a block of wood up to the job, to steady it, before adjusting the hoist.

Be careful of heavy projecting arms on any piece of work, especially when polishing.

Use large centers on heavy jobs.

Slender pieces, held between centers, especially brass or composition metals, should have the tool at least on the center, and never above.

Chuck wrenches should not be left in chucks, when not in use.

Do not forget that the thread-tool and carriage will rapidly reach the tailstock after reversing. You may hurt yourself trying to stop the damage you see it making.

In the lathe, always file left-handed near the dog or lathe chuck. Never use a file without a handle. When filing, always have the sleeve of the left arm rolled up far enough to avoid all danger of catching in the revolving parts.

Do not start a chuck on the spindle with the machine running; do it by hand. It is also better to start the chuck, when removing it from the spindle, by hand rather than by power.

Do not touch a running gear with your fingers under any circumstances.

Do not rest your hand idly on the compound rest; it may be squeezed between the rest and the chuck jaws.

Heavy pieces of work, or pieces of work revolving at a high speed, should be carefully balanced. This applies specially to lathe work.

Lathes, used for turning off the surfaces of electric motor commutators, for example, requiring a high speed, should be fitted with a mica shield placed on the tool-holder and bent over in an arc, so as to cover the point of the tool on the work, thus preventing chips from flying into the workman's face.

In the case of ordinary back-geared engine lathes, milling machines, drilling machines, etc., no attempt should be made to put the back-gearing into action when the machine is running, as this is dangerous to both man and machine.

Keep the countershaft well oiled to prevent the lathe from starting up when the belt is on the idle pulley.

Rules for Milling Machine Operators

Do not put on or take off the milling machine arbor nut by applying the power of the machine.

Do not wipe chips from revolving cutters with the finger or with a measuring scale, and use a brush only on the "off" side of the cutter. In general, do not clear chips away from the work or cutter while the machine is running. Even if a brush is used it is very easy to injure the fingers.

Do not leave a wrench resting on the vertical drive-pulley of a vertical miller. This is a thing that is often done. When the machine is started the wrench is hurled past (at best) the operator's head.

Do not reach across the table while the cutter is running, to regulate the oil-feed; step around to the proper side. Reaching over a revolving cutter with your arm, or assuming positions with the arm near a moving cutter, is always to be avoided.

Using a dull, thin cutter, especially on very hard material, is dangerous.

Rules for Drill Press Operators

In drilling large holes, the work should always be clamped or strapped to the table of the machine or held securely in some other way. Bolt down all work that cannot easily be controlled by hand.

Oil or chips should not be wiped from the drill or work when the machine is running.

Drill operators, both male and female, should wear a cap to prevent the hair from catching in the spindle. Grave accidents have happened to women in this way.

When drilling see that the spindle has no backlash.

If the drill gets "caught" in a piece of work on the drill-press table and the work is whirled around the table, do not try to stop it with the hands, but shut off the power of the machine immediately.

If a drill slips in a chuck while drilling, do not try to tighten the chuck by clasping it in the hand while it is in motion. Stop the machine and tighten the chuck properly with a spanner wrench.

Do not insert the drill drift for removing the drill until the machine comes to a full stop.

Heavy jobs, not being worked on parallel blocks, etc., should not be left lying on the drill-press table while working on another job.

Make sure that circular tables are tightened, before beginning to drill.

Using waste, a file or any piece of metal, to pull chips from a fast running drill, should be avoided. Use a pine stick.

Do not remove parts of a broken drill with a center-punch and hammer. It is dangerous for the eyes.

Make no adjustments in the drill grinder while the machine is in motion.

Rules for Planer and Shaper Operators

Place safety dogs at each end of the planer table to prevent its running off.

When shifting a planer dog be sure that you have plenty of time to do it.

Do not reach under the cross-rail, when the bed is in motion.

Keep your fingers away from the rack feed, if it happens to exist.

When the stroke allows the work to project above the cross-rail, be careful with the planer dogs and yourself, when the bed is in motion.

Do not put the hand between the table and the lower framework of the machine when it is in motion.

On shapers, never take a chance on wiping a chip from the tool when the machine is in operation.

Be sure that the shaper vise is clamped securely to the table to prevent it from being brushed onto the floor.

Do not put a tool in place or take it out with the machine running.

Be sure that a vise, capable of turning or swiveling, is tightened, before you begin to cut.

Do not try to hold a piece, say 18 inches high, in a vise whose jaws have a depth of 2 inches, and then try to take a heavy cut.

Have plenty of room between the ram, at its maximum rear stroke, and any immovable object.

Be sure that the last man using the shaper tightened the head. You may injure yourself, trying to prevent damages.

When a shaper head has been set over, on a short stroke, outside the housing, do not shift to a long stroke before satisfying yourself of clearance between the head and the housing.

Rules for Slotter Operators

Not frequent, but serious accidents occur, due to forgetfulness, when the ram nearly touches the work on the down stroke.

When the ram is up and you are about to start the machine, be sure the tool clears the work. Better lower the ram before putting in a tool.

If you have left a tool in the air for a time on the up-stroke, and then return to the machine, do not start it until you are sure that no movement of the table has occurred.

On the slotter, use a long-handled brush for cleaning away dust or oil from the lines on the work.

Rules for Boring Mill Operators

Tools or metal pieces of any sort should not be left in the T-slots of boring mill tables. They might fly out.

Do not reach under the cross-rail while the table is in motion.

Pulling up chuck-jaws while the table revolves is dangerous unless the table runs very slowly.

When the work nearly reaches the limit of the swing, accidents sometimes occur between the work and the housing.

Rules for Grinding Machine Operators

Heavy spectacles should be worn by emery-wheel operators for protection of the eyes.

Before using an emery wheel, test the soundness of it by tapping it. If there should be a crack in it, it will sound "dead" for a short distance about the crack.

Do not use a grindstone that is badly out of true. Be sure that the tool rest is as near to the stone as possible.

A piece of leather should be attached to the top of the opening of the hood of each emery wheel and so adjusted as to extend down close to the surface of the wheel. This serves to confine the sparks and dust to the hood and to protect the eyes of the operator.

On emery wheels sixteen inches or more in diameter, the rest should not be set more than two inches below the center of the wheel. On wheels less than sixteen inches in diameter the rest should be placed less than two inches below the center. In all cases the rest should be high enough to make it certain that the work will not get caught in such a way as to break the wheel.

In putting a wheel on an arbor, care should be taken to see that the wheel does not bind; it should never be forced on, but should be an easy fit.

Mounting wheels between flanges that bear unevenly when the nut is tightened, is dangerous.

Screwing nuts against wheels not having flanges is not allowable.

Do not allow the arbor to become loose, due to wear.

Keep the wheel true with an efficient wheel dresser.

In nearly all cases it is unnecessary for the operator to stand directly in line with the wheel when grinding, although most operators do so. They subject themselves to unnecessary risk from flying particles entering the eyes. They are also in a place where they will breathe most of the dust, and where, if the wheel should burst, they are sure to receive serious injury. At first it would seem somewhat unhandy to stand at one side of the wheel, but soon the habit will be formed, and it will be found just as convenient as standing directly in front of the wheel.

Rules for Punch Press Operators

When using a punch press, always lock the press and try the trip before changing or setting the dies.

Under no circumstances put your fingers under a shear or punch-press when the power is on. In removing material from the die of a stamping or cutting machine, or punch press, always use the hook provided.

Adjusting or setting dies, or in any way working with the hands between the punch and die, is very dangerous, unless the balance wheel is at rest.

General Rules for Machine Operators

Do not wear jewelry on your hands in the shop.

Before starting, the operator should look carefully over the machine each morning to see if everything is in good working order.

In general, never wipe on or near the running parts of a machine when it is in motion. Shift all belts with a rod rather than by hand. On motor-driven machines take care where the hand is put when throwing the switch.

Do not try to feel the edge of your tool during the reversing stroke on a slotter, planer or shaper; rather stop the machine.

Do not measure or caliper work while the machine is in motion.

Do not start the machine until you are sure that the work is securely clamped in place.

Do not try to tighten the clamps or set-screws while the machine is in motion.

Do not attempt to set the cutting tools while the machine is in motion.

To prevent injury from the end of a rod extending from a screw machine, cut out a piece of light colored cardboard not less than four inches square, make a small hole in the center, and force it onto the end of the stock. This will attract attention.

If waste is caught on a nut, tap or screw do not attempt to withdraw it while the machine is running.

Pieces of steel which may get into the eye should be removed at once to avoid serious injury.

General Rules for the Machine Shop

See that the handles on such tools as files, chisels, hammers, etc., are kept tight and in good repair.

When doing special work above other workmen, notify those underneath; and when doing special work underneath other workmen, notify those above.

When erecting large pieces of machinery, do not throw nuts, bolts or tools from man to man; hand them back and forth.

Do not drop articles from the top of large machines, as they may injure a workman beneath.

When stripping or erecting machinery, before removing one part see that all other parts are held safely.

Avoid the use of nearly stripped bolts and nuts.

When chipping, provide yourself with a mask and eye shield, and see that the tools are not battered, thereby preventing chips from injuring you.

When the head of a cold chisel or punch begins to overlap, grind off the edges, as they may otherwise cause injury to the hand. Do not make a center punch by grinding a round file down to a point. Owing to the brittleness of the file it is liable to break off when struck with a hammer. Do not use an old file as a cold chisel.

When it is necessary to cut off the heads of rivets or to chip brittle substances like cast iron, place a shield to protect other workmen from the flying pieces.

See that the path of your hammer is clear before starting to swing a sledge.

When you complete a job, do not leave tools or material lying overhead. Tear down all temporary scaffolds as soon as you are through with them. Do not allow boards with nails sticking up to lie around anywhere. Many men have been injured by a piece of board lying on the floor with one or more nails in it with the point upward; usually such pieces can be put in a safe place with but little trouble, if the habit is formed.

After repairing machinery, always replace safeguards before leaving the job.

Do not pile any material so high that it is liable to fall.

Leaving articles on large wheels, when stationary, is dangerous.

In storing long bars or poles or pipes, they must never be stood in a perpendicular position, but always given slant enough to make it certain that they will not fall over.

If it can be avoided never stand with your face in line with swiftly moving revolving parts.

Do not use defective machinery and tools until repaired.

Do not use weak or defective ladders, or those that have been spliced to increase their length.

When babbitting boxes for bearings, see that there is no moisture in the mold previous to pouring, as this would cause an explosion. To prevent moisture from being entrapped, heat the piece before babbitting.

When casehardening with cyanide, keep all wet and damp articles away from the heated liquid.

As a last rule: Form careful habits. These will be a protection both to you and to those who work around you.

Belting

Never throw a belt that you are not familiar with over by hand. Examine it first carefully.

Do not attempt to stop a machine by grabbing the belt.

When belts are laced with wire lacings, or any lacings containing metal, take care that no projecting ends are left. Inspect the lacings occasionally to see that the metal lacings have not worn so that they leave a projecting end on either the inner or outer edge of the belt.

When it is necessary to put on a belt, stop the machinery or reduce the speed one-half.

When an overhead belt is caught and begins to wind around the shaft, do not try to release it, but get away from it and have the power shut off immediately. If the belt on an overhead pulley is thrown on by the hand, always pull the belt towards you.

When putting on a belt connecting the countershaft to the main line, put the belt on the countershaft pulley first and then throw it onto the main line pulley.

When throwing off belts, never allow two belts to occupy the same space between two pulleys on the driving shaft.

In replacing an overhead belt upon a pulley while it is in motion, a pole should be used, and the length of the pole should be nearly equal to the distance of the pulley from the floor, thus forcing the man to hold the pole at his side instead of in front of him. A short pole held in front is dangerous. If the belt is too high to be handled with a pole, and it is necessary to use a ladder, the ladder should be placed on the side of the pulley opposite the belt.

Do not lean the end of the ladder against a moving shaft, but rest the end on a stringer or beam.

Do not place a ladder between two shafts to adjust a belt; place it on the outer sides.

After having tightened the clutch fingers, or other parts of a countershaft, do not leave any tools on the stringers overhead as the vibration will cause them to fall down.

Cranes and Hoists

When transferring a chain hoist about the shop, extreme care should be taken not to collide with the moving parts of some machine or with some workman who may not be aware of its approach.

Do not exceed the safe load given by the maker for cranes or jacks.

Do not work underneath loaded cranes unless absolutely necessary.

Do not carry a load on the crane directly over the heads of other workmen.

Do not place the hands on top of the parallel blocks when the crane is lowering a piece onto the machine table. If it is necessary to move a block, do it either with a hook or by placing the hands at the sides in such a way that if the load is lowered suddenly or anything slips, the hands are clear.

Subject cables, chains and slings to frequent inspection.

The shop man is often at a loss to know how large a chain, rope or cable he should use to handle a given weight. The following simple rules which may be stored inside the hat-band where they may be easily found when needed, are, therefore, given. They are intended for ordinary chain, rope, or cable in good condition, with a reasonable factor of safety: For chain, square the number of sixteenths contained in the diameter of the stock that the links are made of, and multiply by 70; the result is the safe load in pounds. For instance, chain made of 1/4 inch stock will carry $4 \times 4 \times 70 = 1120$ pounds, and 1/2 inch chain, $8 \times 8 \times 70 = 4480$ pounds. For rope, square the number of eighths in the diameter and multiply by 30, which gives the safe load in pounds; thus 3/4 inch rope will carry $6 \times 6 \times 30 = 1080$ pounds. For wire cable, square the number of eighths in the diameter and multiply by 100; thus 1/2 inch cable will carry $4 \times 4 \times 100 = 1600$ pounds.

* * *

A WORLD MOVEMENT

Word has just been received of the establishment of the fifteenth Museum of Safety and Industrial Hygiene, this time in Austria. Budapest, Milan, Paris, Moscow, Amsterdam, Copenhagen, Zurich, Munich and Berlin are among other cities where similar museums exist, nearly all of which are generously supported by the government. These institutions are the culmination of years of thought, effort, and scientific demonstration of simple practical methods for preventing accidents. In each case the inception of this work was due to a few earnest and devoted individuals, undaunted by captious criticism, who, by their energy and persistence, brought the work to such a point that the government gladly took it over. Berlin, Munich, Paris, Amsterdam and Milan have outgrown their present buildings and are planning immediate enlargement. In Amsterdam, the city is giving the Safety Museum the site, the state the building, and private subscriptions its maintenance.

The American Museum of Safety, 29 W. 39th St., New York, is non-commercial; it is not a show-room for patented devices; it does not sell or take orders for any of its collections; all demonstrations are made by its own staff, and there is no charge for space. Its object is to study and promote means and methods of safety and industrial hygiene, with their application to any and all public or private occupations, and to advance knowledge of kindred subjects; its special charter authorizes it to establish and maintain a museum, library and laboratories and their branches, wherein all methods and means for improving the general condition of the people as to their safety and health may be studied, tested and promoted, with a view to lessening the number of casualties and avoiding the causes of physical suffering and of premature death; and to disseminate the results of such studies, researches and tests, by means of lectures, exhibitions and publications.

It is cheaper to prevent accidents than to pay for them; the Museum of Safety, through its three-fold departments of prevention, industrial hygiene and mutuality, prevents accidents, lessens law suits for compensation, and creates mutuality between employer and employes. Now let us conserve human life.

The Dresden international exposition on accident prevention and industrial hygiene, now drawing to a close, has set the seal of world approval on these problems. The apathy and indifference of our government towards these questions, evidenced by its refusal to participate in this exposition is deplorable. The Germans, who are so keen in the scientific solutions of these questions, were bitter in their denunciation of the United States because it declined to be identified with this humanitarian movement. As they so justly remarked, "What subject touches the government more closely than the safety of its citizens and the conservation of their health?" Therefore our indifference towards these vital subjects is incomprehensible to them.

The success of this exposition was largely due to individual effort and the generous financial support of industrialists like Lingner, who, at his own expense built and equipped the great central building called "Der Mensch," in cooperation with a corps of scientists, statisticians and doctors. No pains were spared to make the exhibits simple and convincing; the success was unparalleled, as never before in the history of expositions has a work been carried to such perfection. Dresden has set an example which will be difficult to surpass. Up to September 1, four millions of people enjoyed the privileges of studying at this monumental school of life and labor. In fact, there is such a popular demand that these collections should not be dispersed, but find a permanent home, that it has been decided to found for them an institution, which will become, in Dresden, another Museum of Safety and Industrial Hygiene.

The American Museum of Safety is dependent on memberships and subscriptions; it is imperative that this life-saving work should be housed in its own building, so as to provide for immediate expansion, as it has already outgrown its present quarters. To make this a monumental institution for America, that shall rank in scientific research and practical results with the great continental museums of safety, every American should take a personal and patriotic interest, by becoming a part of it.

If every citizen would give the price of one brick toward the construction of this building, it could be begun at once. No contribution is too small; in this way all can become an integral part of a great educational institution for the safety of the people, which should be the first of its kind in the world.

* * *

A machine is never made with brains; therefore, it is up to the operator to do the thinking and lend a guiding hand.

FIRE PROTECTION IN FACTORIES

AS ILLUSTRATED BY THE WARNER BROTHERS CO.'S PRIVATE FIRE DEPARTMENT SYSTEM

By CHESTER L. LUCAS*

The subject of protection against fire in machine shops and factories seems to be a neglected one. The importance of the matter frequently manifests itself by the occurrence of disastrous fires, but as regards the small factory, at least, the lesson seems difficult to learn. One of the best protected factories against fire, is the Warner Brothers Co.'s shops in Bridgeport, Conn., where the property of the company and the lives and interests of its employes are effectually guarded by a private fire department competent to put out small fires, and to hold in check larger fires until the arrival of the municipal fire department. Through the courtesy of Mr. F. E. Warner, of the above company, and Mr. J. W. Keppy, master mechanic of the factory and chief of the company's fire department, the following description of the system, and the photographs of its leading features, are presented.

In this factory, the headquarters of the fire protection system are located in the office. Upon the walls are drawings, showing the entire plant in perspective, the underground conduits and piping, the watchmen's circuits, and the color scheme of the piping throughout the factory. Copies of these drawings are also posted in the engine-room and other places where they may be studied by those who should familiarize themselves with these details. The perspective view of the plant shows the location of each building, the entrance and exits, stairways, and in fact every detail of the property. Fig. 2 is a reproduction of one of this drawings. Every building is numbered, and known by its number. A drawing of the conduits and underground piping of all kinds, fire supply, water, sewer, gas and heating, is also posted in the office. This drawing also shows all hydrants, manholes and outside valves, enabling the men to locate the lines easily in case of such trouble as breaks in the pipes and the like.

Standard Pipe Colors

The color scheme employed for designating the different kinds of pipe lines is very complete. It is carried farther than is customary in most shops. Too much cannot be said in favor of using colors for the various classes of pipes, for it is obvious that much time is thereby saved when tracing or inspecting piping, and many accidents have been averted in cases where the workmen were inclined to be careless.

Fig. 3 represents the color chart for piping, copies of which are posted in the drafting-room, pipe shop, and engine-room. On the original charts, the piping is colored according to the adopted system for the shop piping. In Fig. 4 is shown a corner of the shop with a number of different kinds of pipes painted in accordance with the system. Thus, the steam pipes are black, the sprinkler pipe is red, the soil pipe is green and red, the electric lines are yellow, and the watchman's station is yellow and black. The fire pail is, of course, red. While apart from the subject, the orderly arrangement at the end of the lathe in this illustration is commendable—the racks to contain the chucks, back-rest, and faceplates, and the tool-chest above.

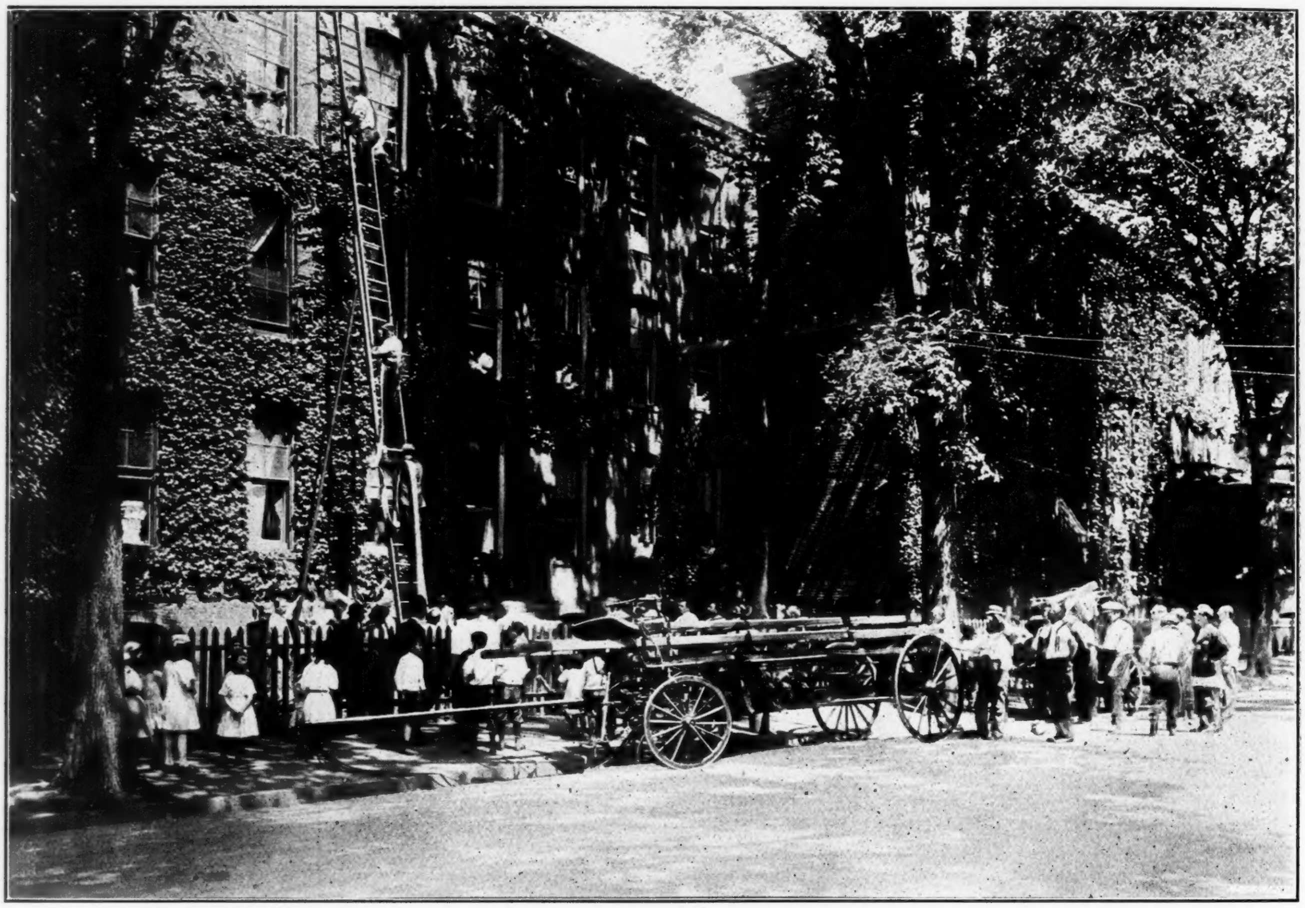


Fig. 1. In less than Three Minutes the Private Fire Department had their Men and Apparatus on the Scene, with a Ladder up and a Line of Hose ready for a Stream of Water

A list of the standard pipe colors in use in the Warner Brothers Co.'s shops is as follows:

Use	Pipe	Fittings
Hot Water	Blue	Red
Cold Water	Blue	Blue
Sprinkler	Red	Red
H. P. Steam	White	White
L. P. Steam	Black	Black
Exhaust Steam	Black	Red
Returns	Black	White
Blower, air	Brown	Brown
Exhaust, air	Brown	White stripe
Gas	Brown	Red
Oil	Drab	Drab
Conductors	Green	Green
Soil	Green	Red
Vent	Green	White
Light Conduits	Yellow	Yellow
Power Conduits	Yellow	Red
Bell Wires	Yellow	Green
Fire Alarm	Red	Yellow
Watchman's Clocks	Yellow	Black
Telephone Conduits	Yellow	Brown

Watchmen

The night watchmen in this factory carry no lanterns. Two or three incandescent lamps are placed in each department to furnish light enough to enable the watchmen to walk through

* Associate Editor of MACHINERY.

and find their stations. Of course if the necessity arises, the entire room may be lighted by throwing in the proper switch. With a lighted lantern in a watchman's hands, there is at least some danger from fire, but the most important reason for not carrying a lantern is to prevent a person without the factory from tracing the watchman's movements by means

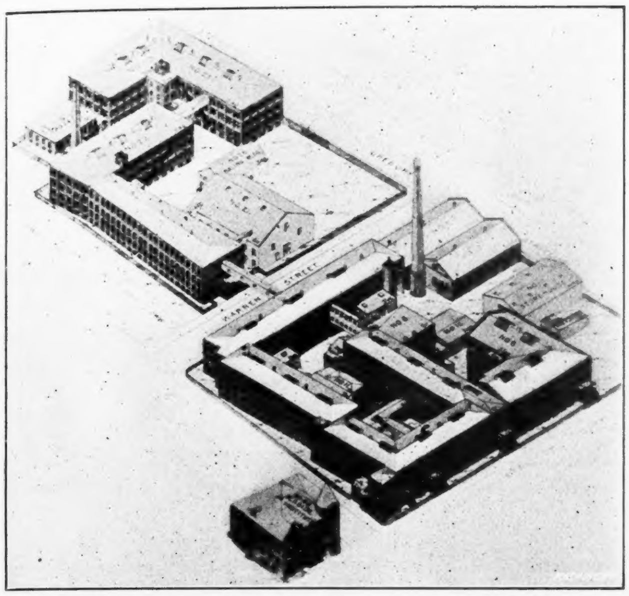


Fig. 2. Perspective View of the Plant showing every Building on the Property

of the lantern. A case recently occurred in eastern Massachusetts that brought this point into the limelight. In this instance the watchman was shot by a robber, who, outside of the factory, could get no better assistance in aiming than that provided by the lantern in the watchman's hands. The watchmen have regular routes, and register at numbered sta-

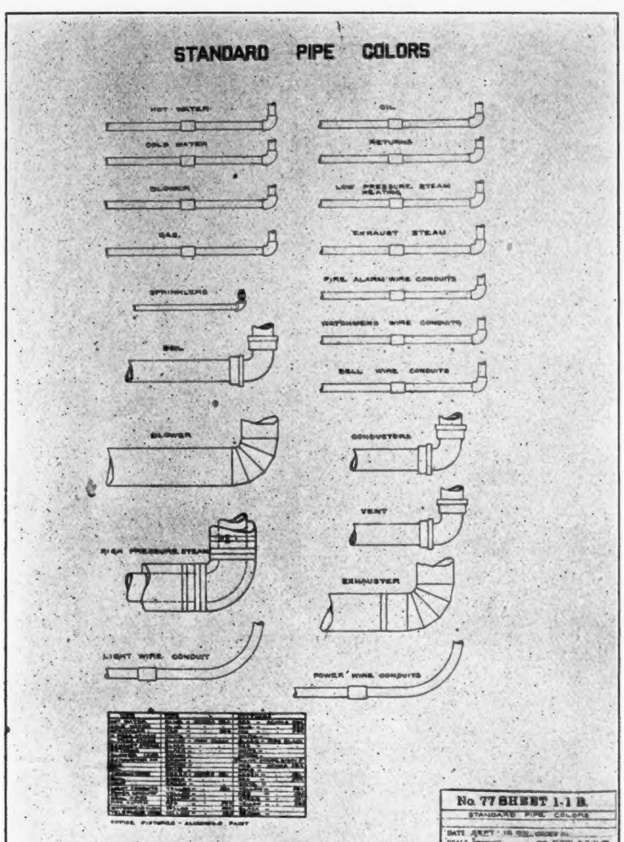


Fig. 3. Charts showing the Standard Colors for Piping are hung in the Engine Room and Pipe Shop

tions at intervals. It requires half an hour to cover each beat. The watchman then rests for half an hour, following this order all night. The Echo magneto system is used for recording the watchman's work. The watchmen have stated ground to cover between certain periods, and it is easy to locate them at any time, should they be needed.

A large keyboard in the main office (shown in Fig. 6) contains duplicate keys for every lock in the plant. Nearby is a list, enabling any key to be located in a few seconds, if an emergency should arise. For instance, in case of fire, it might be important that certain drawings, partly completed and on the drafting boards, should be removed from danger. If the drafting-room were locked, the duplicate key could quickly be found in the office, and the room entered without delay. Master keys that will unlock any gate in the plant are carried by Mr. F. E. Warner and Chief Keppy, of the private fire department, who live but a stone's throw from the factory.

Care of Waste and Paper and Cloth Scrap

A source of many fires is traceable to improper methods of keeping cotton waste, especially after it has been soiled. In this shop, the supply of waste is kept in sheet-iron boxes, the covers of which are kept closed. All soiled waste is burned each night under the furnaces. A large amount of strawboard clippings and cloth trimmings are left over from the manufactured product. Unless properly disposed of, there

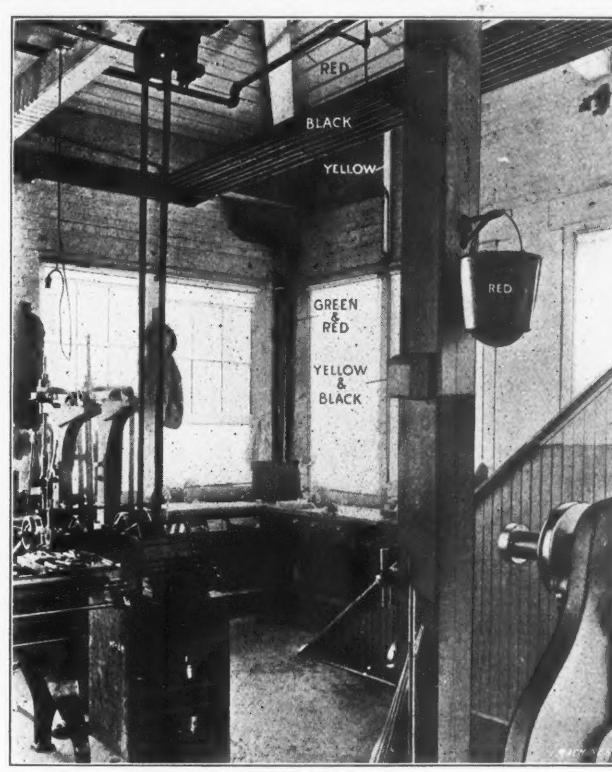


Fig. 4. A Practical Application of the Color Scheme of the Piping

would be considerable danger in case of fire, for strawboard, particularly, is very inflammable. As there is more or less value in this material, the trimmings are baled and sold to paper manufacturers. The baling press is shown in Fig. 5; though very simple, it is powerful, and with its use over a carload of strawboard clippings is baled each week. After laying a strip of burlap in place in the baling press, the strawboard or cloth is thrown into the chute from the floor above, the lid is put in place, and the pressure applied. An eight-inch pinion on the same shaft as the driving pulley engages the five-foot gear shown, winding up the chain which runs over a sheave whose shaft presses upon the top lid of the press. As soon as the bale is compressed, the wires are fastened in place, and the bale removed by swinging the front of the baling chamber out of the way.

Cleanliness is one of the first requisites of fire protection. The yards are covered with fine gravel and kept scrupulously clean. All hydrants are painted with their proper color and numbered. An improved type of outside fire escape is used. This differs from the ordinary type in that the descent is more gradual, and more like that of ordinary stairs, thus lessening the danger from crowding and falling when leaving a building in case of fire. This type of fire escape is especially to be advocated where many women are employed.

Fire Pails—Extinguishers—Sprinklers

Fire pails are hung at intervals throughout the factory. Fig. 7 shows the type of fire pails used. They are painted a

bright red and have rounded bottoms, thus discouraging their use for any other purpose. These pails are hung upon posts about fifty feet apart, except where there is apt to be special need of them, in which case they are placed closer. Fig. 7 illustrates a particularly dangerous spot in the tool-room (and such a spot there is in every tool-room), at the forge, where there is a fire most of the time. Water is a poor weapon against oil or japan fires, and for this reason pails of sand

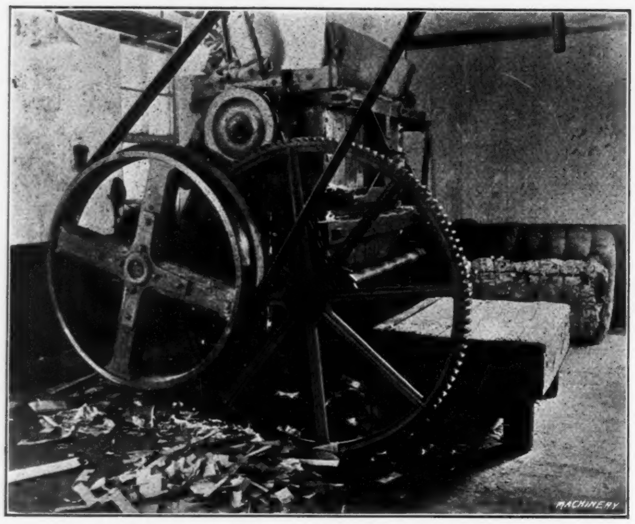


Fig. 5. Strawboard Clippings and Cloth Trimmings are baled and shipped without Delay

are kept on hand in the japanning rooms. Fig. 8 shows a few of these sand pails, always at hand where oil or japan are used to any extent.

On the right of the exit in Fig. 9 is one of the numerous fire extinguishers that are placed upon the walls at intervals throughout the factory. These extinguishers are of the "Pyrene" make, and are said to be very effective in putting out fires of any kind, oil and japan fires included. All parts of the factory are protected with automatic sprinklers. It is unnecessary to describe this important protective device. The sprinker heads are regularly tested, and an even pressure is maintained by an auxiliary pump in the engine-room. The laws relating to sprinklers vary in different states, but in Connecticut the sprinkler heads must open upward, thus taking care of ceiling fires as well as floor fires. This provision also does away with accidental sprinkler action, caused by hitting the sprinkler head with a ladder or a belt pole.

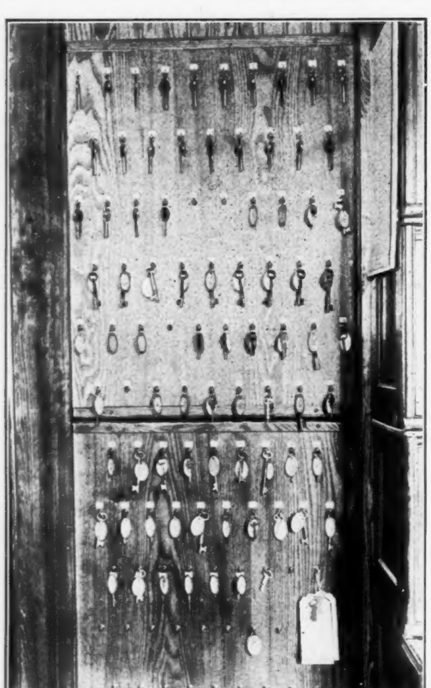


Fig. 6. A Large Keyboard in the Office contains Duplicate Keys for every Lock in the Plant

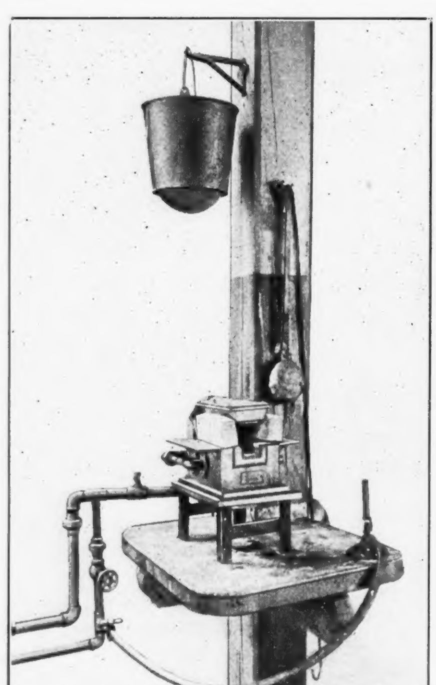


Fig. 7. Fire Pails are always at Hand where there is Special Danger from Fire

Fig. 8. Fire Doors separate Departments and Sand Pails are provided where Oil or Japan is used

Systematic Action in Case of Fire

If a small blaze should break out in any department, the instructions are to get as many fire extinguishers as are necessary to put out the fire, also using the pails of water or sand that are provided for the purpose. It is specially ruled by the chief that one extinguisher shall be held in reserve, for in the excitement, all of the extinguishers might be emptied at once, leaving none for an emergency.

Of course, if the fire bids fair to be other than a small one, an alarm must be pulled in at once from one of the numerous signal boxes, and all enclosing fire doors shut at once, before attempting to cope with the fire. The fire doors are covered with heavy sheet iron and run upon slanting overhead tracks. The doors are balanced with heavy iron weights much the same as windows are balanced. The weight ropes are attached to the doors with fusible links. Thus, should a door remain open during a fire, the link will melt as soon as a very slight heat reaches it, and the door will close at once. To demonstrate this point, a lighted match held under the link caused the link to melt and the door to close.

Small signal alarm boxes are placed upon the walls throughout the factory. An alarm given from one of these boxes is transmitted to the engine-room. The engineer promptly blows the factory whistle, and by means of a set of push-buttons, he sends the alarm to an indicator box at the apparatus house. The first fire department officer who reaches the apparatus house takes charge of the men and directs them to the fire. As soon as an alarm of fire rings, the operatives file from the buildings by means of the numerous exits. The exit doors that lead from the shops are lettered and numbered with very large, plain lettering, as shown in Fig. 9. The words "No. 23, 3rd floor" signify that this is the exit from the third floor of building No. 23.

The Private Fire Department

The Warner Brothers Co.'s fire department was organized in 1886 to protect the property of the company and the lives of its employes. The department is composed of fifty men, equally divided into two companies, hose and ladder. These companies are shown in Figs. 10 and 11. In selecting members, consideration is given to physical condition, steadiness in the work and proximity of residence to the factory. This last requirement is necessary on account of the importance of responding to fires that might occur outside of the factory hours. Each member is provided with a badge which must be worn at all times while within the factory. In addition,

each man is given a uniform that is to be used when on parades, or on other representative occasions.

Although these firemen receive no additional pay for this special duty, they get many benefits that they would not otherwise receive. In dull times the fire department members are always employed. They have formed a mutual benefit association among themselves that tends to bind them together, and protects them in times of sickness. In addition, the Warner Brothers Co. pays each fireman ten dollars per week, if incapacitated while attending to his duties as fireman.

The most important feature holding together the fire department and cultivating the spirit of loyalty, is, however, the Seaside Institute. Originally, the Seaside Institute was opened for welfare work among the operatives of the Warner Brothers Co.'s factory. It was given by Dr. Warner, the founder of the business, and is maintained by the company as a place for recreation, baths, etc., without cost to the employes. Inside and outside, the Seaside Institute much resembles a club house, and, indeed, it is a club for the employes, male and female. On the top floor of the Seaside Institute, several rooms are given over to the fire department. There is an assembly room, where the members hold their monthly meetings. There is also a smoking room and a billiard room,

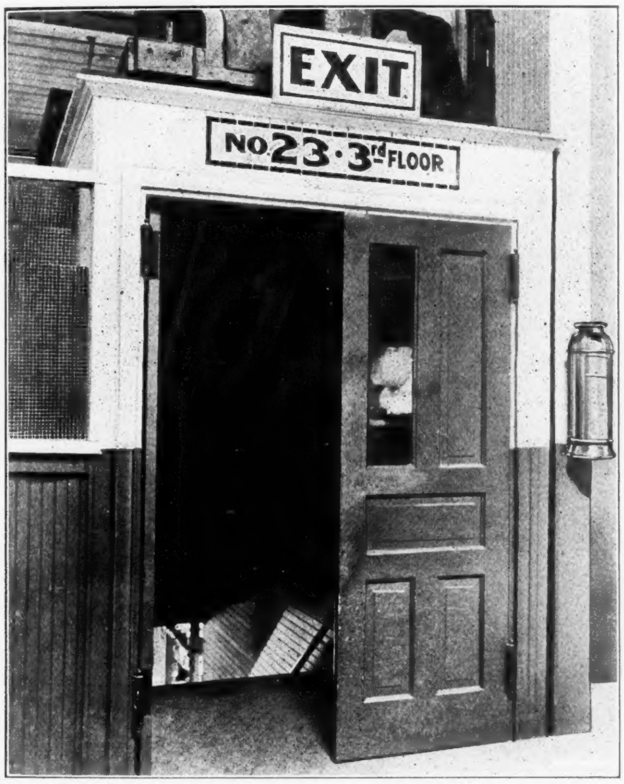


Fig. 9. The Exits are plainly numbered with the Building and Floor Numbers

where the winter evenings may be spent in recreation. Besides these rooms, there is a large auditorium in which lectures and entertainments are given, and by removing the seats, dances and card parties can be held. All of these features help to make the men proud of their organization, and throughout the factory it is considered an honor to belong to the fire department.

The company has presented the fire department with a large silk banner, which is carried in parades. To further promote the welfare of the men as a body, the department frequently visits other fire companies. On September 2, this year, they journeyed to Allentown, Pa., to visit the Good Will company of that city.

A fire department of this kind would not long remain strong, nor do efficient work, without good officers. Since its organization over twenty-five years ago, Mr. J. W. Keppy has been its chief. There are also captains and lieutenants for each of the companies. A booklet is printed containing by-laws by which the department is governed.

Fire Drills

In order to keep the fire department efficient, alarms are pulled each week at unexpected times. As these alarms may be sounded at any time between 7 A. M. Monday morning and 12 o'clock Saturday noon, the men are never sure that the alarm is not for a genuine fire.

To illustrate the working of the drill, Mr. Keppy, the chief, pulled an alarm from a distant part of the plant, at exactly 11:35 A. M. A camera was focused upon a part of the outside of one of the buildings. Before the elapse of two minutes, the two companies, pulling their hose and ladder trucks, came

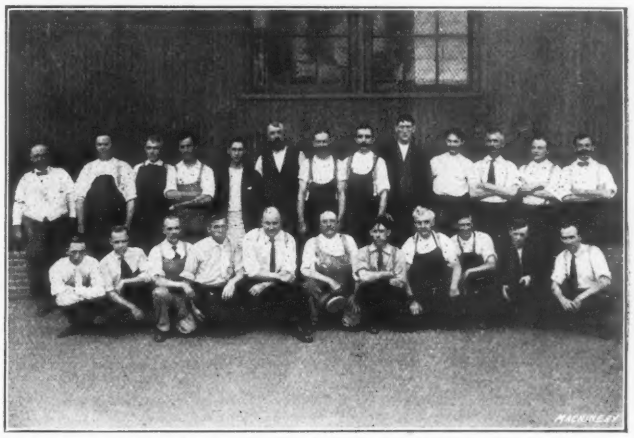


Fig. 10. The Ladder Company, just as they have left their Work

running around the corner. In less than another minute, a ladder was out and run to the top of the three-story building, hose had been laid to the nearest hydrant, and the nozzleman was at the top of the ladder, ready for a stream of water. It was good work, and would have done credit to professional fire fighters. At the conclusion of each drill, the roll is called, and absentees are fined a small amount.

Apparatus

The hose team and ladder truck maintained by this company are shown in Fig. 1. The apparatus is complete in every respect, including extension ladders, short ladders and poles for steadying, as well as a good supply of hose, nozzles and fittings. The apparatus is used without horses, on the short distances about the factory. The houses in which the hose team and ladder truck are kept, are located on the side of one of the streets that bound the plant. The men that comprise the companies are from all departments of the factory, from sweepers to foremen. In Figs. 10 and 11, the men appear just as they have left their work in the shop to answer to the alarm. Chief Keppy appears on the left end of each group.

One of the important features of the fire fighting apparatus is the pair of Worthington fire pumps, in the engine-room, which can be thrown into action at any minute, night or day.

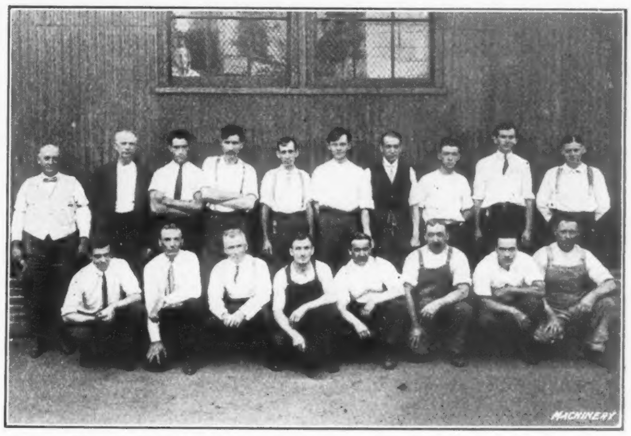


Fig. 11. The Hose Company, with Chief Keppy on the Left

They each have a capacity of pumping one thousand gallons per minute, which is equivalent to four good smooth nozzle streams, each one and one-half inch in diameter.

Credit is due to Mr. Frederick C. Moore, superintendent of the inspection department of the Hartford Fire Insurance Co., for assistance in the preparation of this article. The prevention of fire dangers is closely allied to the prevention of accidents in the industries, and the two subjects should receive equal attention.

MILLING RADIAL TEETH IN CUTTER BLANKS—1*†

By GEORGE W. BURLEY‡

When radial teeth, such as the side teeth of slot-milling cutters and the end teeth of end-mills, have to be milled, it is necessary to set the cutter blank at an angle in order to produce uniform widths of "land" on the teeth. The usual formula which is employed for figuring out this angle of elevation of the index-head is as follows:

$$\cos\theta = \tan\phi \cot a \qquad (1)$$

in which,

θ = angle of elevation of index-head (see Fig. 1).

ϕ = tooth angle of cutter blank, or $\dfrac{360 \text{ degrees}}{\text{number of teetn}}$ (see Fig. 2).

a = grooving cutter angle.

The method of determining the depth of cut at the circumference of the cutter blank is, however, not so well known, and it is for this reason that this article has been written.

In Fig. 1 the conditions of the problem are indicated. The angle θ is the angle of elevation of the index-head, and is obtained by Formula (1); and d is the depth of cut required. It will be noticed that this is the maximum depth of cut, and that it is measured at the circumference of the cutter blank, or in other words, at the highest point of the blank in its inclined position. A (see Fig. 2) is a dimension which is somewhat less than the radius of the blank, its determination being dealt with hereafter.

From the geometry of the figure, $\dfrac{d}{A} = \cos\theta$. Therefore

$$d = A \cos\theta \qquad (2)$$

Fig. 2 is a part plan of a cutter having radial teeth. Here it can be seen that A is equal to $R - B$, where R = the radius

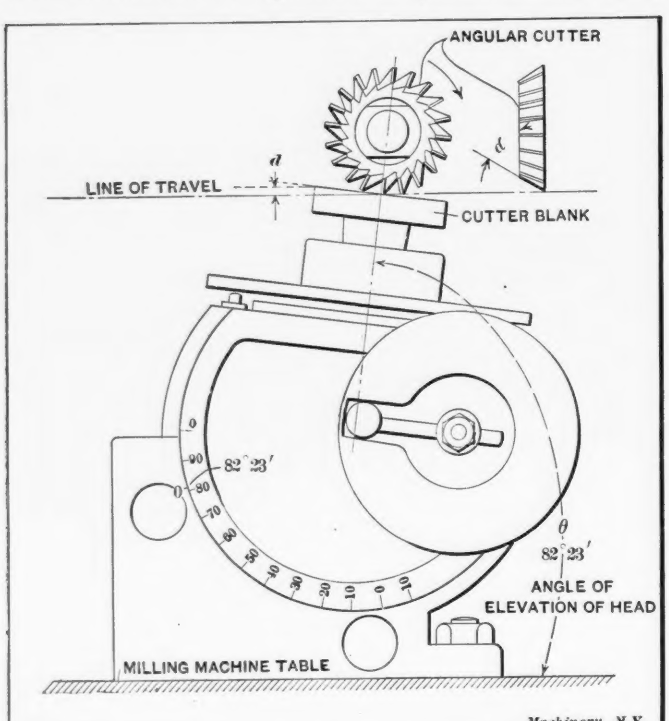


Fig. 1. Diagram for Calculating Angle of Elevation of Index-head

of the cutter blank, and B = the distance XY, which is equal to $\dfrac{W}{\sin\phi}$, W being the width of the tooth-land measured in the plane of the side face of the cutter (*i. e.*, normal to its axis), and at right angles to the cutting edge of the tooth. It should be observed here that X is the point where the grooving or spacing cutter would leave the blank if the latter were fed along far enough and had no recesses in its side faces.

$$\text{Since } B = \frac{W}{\sin\phi}\ R - B = R - \frac{W}{\sin\phi},\ \text{and } d = \left(R - \frac{W}{\sin\phi}\right)\cos\theta$$

$$\text{Then } d \text{ in terms of } R = R\left(1 - \frac{W}{R\sin\phi}\right)\cos\theta \qquad (3)$$

Of the quantities involved in this expression, all but d and W are known or easily obtainable; however, d is the value which is required, so that if we can obtain a value for W we can readily solve the equation for d. In regard to the obtain-

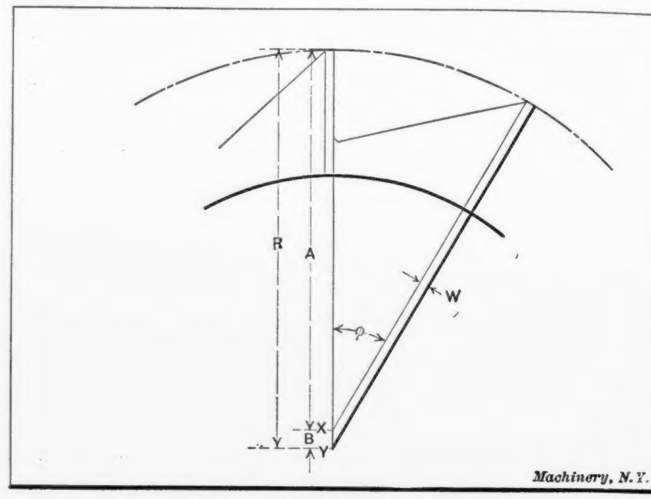


Fig. 2. Part Plan of a Side Milling Cutter, illustrating Method of Determining Width of Land, etc.

ment of W, we can either select a value for it or for $\dfrac{W}{R}$. This latter quantity is one which is fairly constant, varying from 0.017 to 0.033 inch, giving an average value of 0.025 inch. This average value is representative of the latest practice. Introducing the value of W in Formula (3), we get:

$$d = R\left(1 - \frac{0.025}{\sin\phi}\right)\cos\theta \qquad (4)$$

which is the expression wanted under the stated conditions.

[Modified formulas for common practice will be given in the second and concluding installment. The Data Sheet, giving width of land and depth of cut, will also be continued to comprise cutters from 30 to 52 teeth, inclusive.—EDITOR.]

* With Data Sheet Supplement.

† For additional information on this and kindred subjects see: "Setting Angles for Milling Angular Cutters and Taper Reamers"; November, 1908, engineering edition, and other articles there referred to.

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* * *

IMPROVED CONSULAR SERVICE

As the consular officers are seldom in a position to represent the industries of their country, so far as it relates to questions of a purely technical nature, because they do not possess the necessary professional knowledge, it has been proposed in Germany to assign technical experts to various important German consulates. The activity of these experts will be largely confined to following the progress of the industrial developments of foreign countries, and to report on the advance in the engineering field. Considering the meager return to the engineering and industrial interests of a country from the reports of the consular service, it seems that this is a move well worth imitating by any nation desiring to serve its industries with useful information. Whether, however, the technical expert stationed in a foreign city will be able to report on engineering matters in such a manner that his reports will be of direct value to the industries of the country is somewhat doubtful. The field he will have to cover will be very broad, and of necessity he can have but a limited knowledge of the many subjects upon which he will be called to report.

* * *

Cromwell Dixon, the aviator who flew across the Rocky Mountains, September 30, fell at the Inter-State fair grounds at Spokane, Wash., October 2, and received injuries that caused his death. According to published statistics, Dixon's death makes the ninety-eighth fatality connected with aeroplanes since Lieut. Selfridge's death in 1908.

THE METAL-WORKING INDUSTRIES OF DUSSELDORF

THEIR EXTENT AND VARIETY—SHOP CONDITIONS AND SURROUNDINGS WHICH ATTRACT AND RETAIN SKILLED LABOR

By C. A. TUPPER*

In no part of Germany will the American traveler who wishes to investigate the differences between methods of metal-working at home and abroad find so many valuable suggestions as in Düsseldorf and vicinity; nor will he conceive, anywhere, a greater admiration for what is best and most progressive in German practice. For a European trip of relatively short duration, such as most American business men feel obliged to take, if they are to go at all, Düsseldorf is the best possible objective point.

The city itself has a number of important industrial districts. In Oberbilk, which is the nearest to the Hauptbahnhof, or main railway station, one finds the Aktien-Gesellschaft Oberbilker Stahlwerk, formerly C. Poensgen; Giesbers & Cie, fabricators of pressed steel; the Düsseldorf Rohr und Eisenwalzwerk Akt. Ges.; Rohrwalzwerk Piedboeuf and Walzwerk Oberbilk, tube and rolling mills; the Akt. Ges. Düsseldorfer Eisenbahnbedarf, manufacturers of railway supplies; the machine shops of Fischer & Cie.; the plant of Hein-Lehmann & Cie. Akt. Ges., builders of railway and bridge material, signal systems, etc.; the works of the A. Hahn Akt. Ges., and others. The adjacent district of Lierenfeld contains the factory of the Gebrüder Inden; the machine-tool building plant of Habersang & Zinsen, or Düsseldorfer Werkzeugfabrik; the Düsseldorfer Rohren und Eisenwalzwerk, rolling mills; the iron and steel fabricating shops of the Oeking Akt. Ges., whose product includes gear wheels of very large size; and a number of boiler works and metal-working plants extending through what was formerly the village of Klein Eller.

Between Flingern and Grafenberg, above Lierenfeld, are the great foundries, forging and machine works of Haniel & Lueg; and on the way one passes the iron works of Senf & Heye; the sheet-metal works of Springerum & Cie.; and, some distance to the left, the Düsseldorfer Rohren-Industrie, or tube mills and pipe factory, as well as various furnaces and kilns. At Ratingen are the Eschweiler-Ratingen Maschinenbau Akt. Ges., outfitters of pipe and drawn steel products plants; and the home of the celebrated Dürr water-tube boilers, the Düsseldorfer-Ratingen Rohrenkessel Fabrik, formerly Dürr & Cie. Others, the locations of which the writer does not recall clearly, from having visited them in a closed automobile on a rainy day, are Hartung, Kuhn & Cie., who do a world-wide business in governors for engines, turbines, compressors and pumps; and Wellman, Seaver & Head, Ltd., manufacturers of charging machines, strippers, etc., for open hearth furnaces. The latter is a branch of the Wellman-Seaver-Morgan Co. of Cleveland, O.

Haniel & Lueg, from whose plant the illustrations accompanying this article are taken, are builders of heavy machinery, including large gas and steam engines, blowing engines, steam-hydraulic forging presses and other equipment for complete hydraulic plants, mining machinery and pumps, material for steel ships, heavy forgings for cranks, shafts, propellers, etc., boilers and plate work, large castings, etc. The equipment of the shops is thoroughly modern in character, and all tools, except the hammers and forging presses, are electrically operated and controlled. From the foregoing it will be seen that the work is mostly of a special character and calls for the utmost skill; hence, the standard of wages corresponds with the high grade of the labor. The firm has never experienced any serious labor difficulties and succeeds in keeping good men a long time in its employ. The grounds of the establishment occupy over 30 acres, nearly half of which is covered by shop buildings. From a small beginning in 1872, the firm has come to employ upwards of 2000 men.

In the steel works are three furnaces, of 30, 40 and 60 tons capacity, of the Siemens-Martin type, for the production of ingots of both mild open-hearth and nickel steel, suitable for forgings weighing up to 70 tons. Steel castings as heavy as 60 tons are also turned out. In making the ingots and castings, a special process is used which tends to leave them free from internal defects, and the good results thus obtained

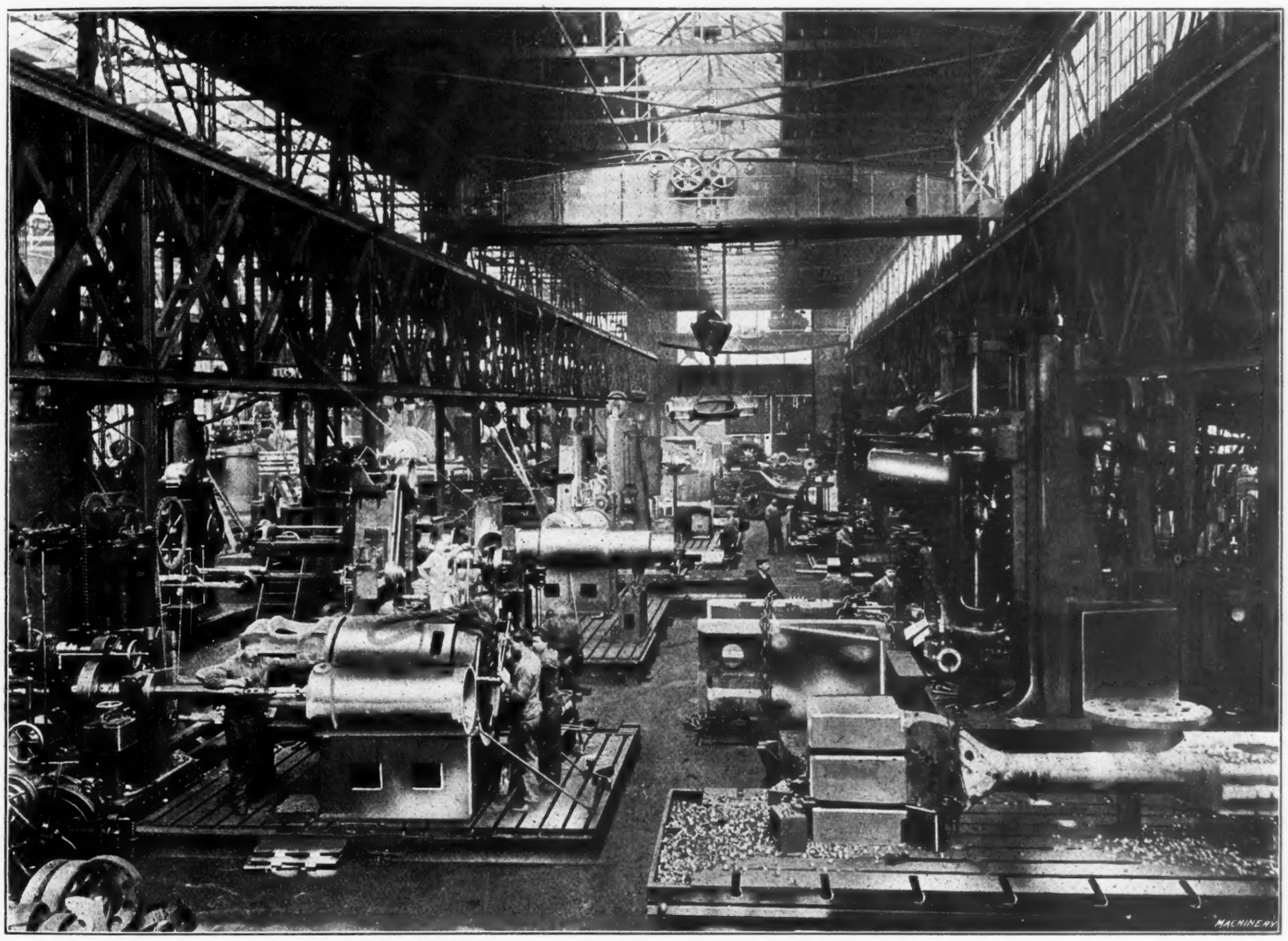

Fig. 1. Machine Shop No. 1 of the Firm of Haniel & Lueg, Dusseldorf

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are further improved upon by careful reheating and annealing, for which seventeen auxiliary furnaces have been provided. In this department there are eight steam hammers, from the smaller sizes to the largest, with suitable cranes to facilitate the handling of the work. The iron foundry has three cupola furnaces and is capable of producing the largest castings required for gas engine frames or other heavy parts.

The most interesting section of the works, outside of the machine shops, is the steam-hydraulic forging department, a view of which is shown in Fig. 2. This illustration shows a 2500-ton forging press of the firm's own design, duplicates of which have been built for other forging plants, notably in England. There are also presses in operation of 500 and 1800 tons working pressure, constructed on similar lines. These three presses are used in forming steel shafts, rods, cranks, and parts such as stern posts, rudder frames, etc., required in ship building.

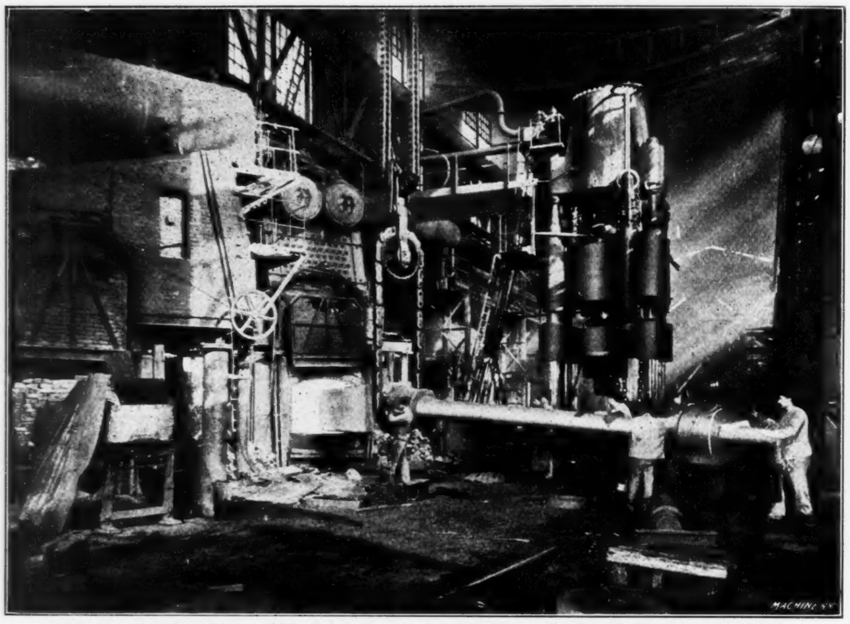


Fig. 2. Forging Shop of Haniel & Lueg, showing Steam-hydraulic Forging Presses

Fig. 1 shows the main bay of machine shop No. 1, with stationary and portable tools working on independent floor-plates, which appear to be used with as good results as the continuous floor-plates that are coming into vogue in this country. Great pains are taken to so arrange the tools that heavy work may be routed through the shop in such a manner as to insure the minimum of handling. Except for an irregular space between the floor-plates, there is no aisle, and practically no material is transported at ground level, two large cranes being kept in almost constant service for this purpose. The other machine shops are similarly arranged. Fig. 3 shows a view of a section of the erecting shop, where mine pumps are being assembled. The ample head-room will be noted by comparing it with the height of the man to the right of the center.

Careful provision is made for the welfare and comfort of the men. The firm of Haniel & Lueg believes that, in addition to being a good thing in itself, it increases the efficiency of labor. At the works each man has his own locker, and a change of clothes is customarily made upon entering and leaving. There are also baths and lavatories, with soap and towels provided, and steam heaters for drying garments during wet weather. When it is cold or stormy, the men take their noon meal in a mess room, with which a canteen is connected. Food and liquid refreshment may be purchased here at low prices. The writer believes that coffee is furnished free by the firm, but is not positive on that point. In the summertime meals are eaten out of doors in an extensive, well-kept garden, and the men frequently have, at noon, the company of their wives or other members of their families.

The average day's wage in the works amounts to about \$1.20, but on piece-work the skilled men make very much more. For molders and machinists it varies, say, between \$1.80 and \$2.90, including a system of bonuses. Spoiled work is penalized by deductions from the bonus. In the forging department, where the men work in gangs, the first man earns about \$2.50 for the day, and the others are paid at a lower rate, with a premium placed upon good work. There is also a system of gratuities for employes who have been in the service ten years or more. A savings bank is maintained by the firm, which allows a good rate of interest, and advantage of it is very generally taken by the men. Wages do not expand and shrink with conditions of trade, but are kept at a uniform, although gradually rising, level. The variety of the work done by the firm and the fact that its shops have had plenty of work, even in dull seasons, has enabled it to maintain this policy when less fortunate concerns might not have found it possible to do so; but there is, no doubt, a direct relation to be traced between keeping a large force of trained men satisfied, and having the work for them to do.

There is a circulating library at the shops, having nearly 5000 volumes. An ambulance service and hospital have been provided for accidents or cases of serious illness, and the firm even maintains a maternity hospital for the wives of the men. Especial attention is devoted to apprentices, who receive only a small daily wage, but who are allowed to attend continuation schools for a certain number of hours each week.

The hours of labor are from 6:30 A. M. to 12:00 M., and from 1:30 P. M. to 6:30 P. M. This would be considered a long day in our country, but the men enjoy a noon rest of an hour and a half, and they are also given a quarter hour, both in the morning and afternoon, for further refreshment. Furthermore, their personal cleanliness, bodily comfort and general working conditions, with good light, ventilation, etc., are so carefully looked after, that men accustomed to military discipline thrive under this routine; and the state of their minds is reflected in the neat, orderly character of the shops and the work.

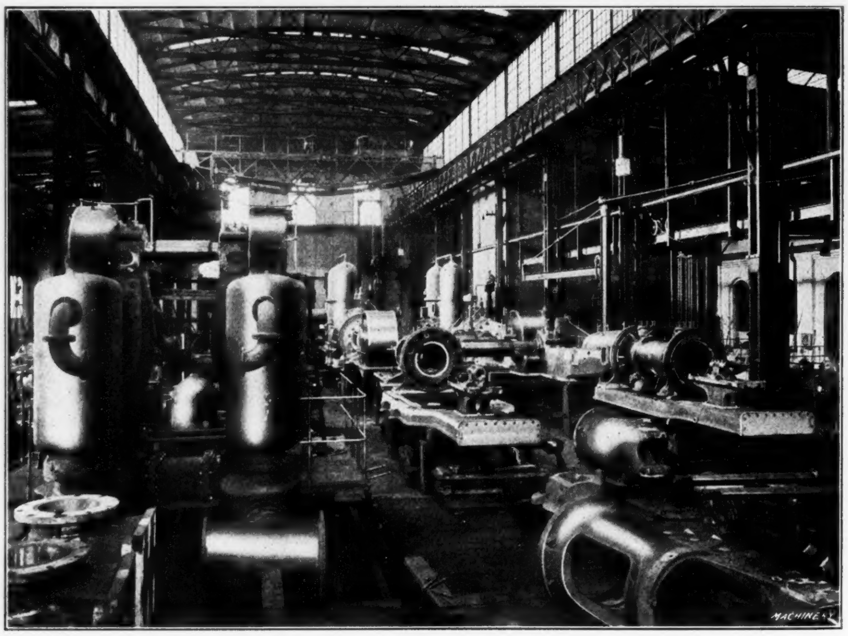


Fig. 3. A Section of the Erecting Shop for Mine Pumps

Another notable Düsseldorf plant, and one of the most interesting in Europe, is that of the Ernst Schiess Werkzeugmaschinenfabrik Akt. Ges., located almost in the center of the city. This concern was founded in 1866 by Dr. Ernst Schiess,

now chairman of the Board. Since 1869, a period of 42 years, nearly 12,000 tools have been built. The significance of this may be better appreciated when it is realized that the company makes a specialty of very heavy machines used in the manufacture of armor, ordnance, steam turbines, engines, and of plates for furnace construction, ship building and the like. The company operates in conjunction with a plant at Riga, Russia, formerly known as Felser & Co. Although the Düsseldorf works are so situated that the surrounding real-estate is very valuable, they have been steadily enlarged and occupy now a site of 13½ acres. About 1200 men are employed. Part of the erecting shop for heavy machine tools is shown in Fig. 4.

A plant of nearly equal interest to the Haniel & Lueg and Schiess establishments is that of the De Fries & Co. Akt. Ges., which is especially well known in the United States from the fact that this company has the agency for many tools of American manufacture, which it sells in connection with its own. There are also more American machines in use in these works than in the other shops described. The plant is located at Heerdt, a suburb of Düsseldorf, situated a short distance across the Rhine beyond Ober-Cassel.

In the city are also located the Mannesman-Rohrenwerke, whose specialty is seamless drawn and welded tubing, the Press und Walzwerk Akt. Ges., Düsseldorf-Reisholz, manufacturers of rolled, drawn and pressed steel products; De Limon Fluhme & Co., makers of hydraulic presses and accumulators, machinery for tube mills, gears, castings, etc.; the boiler and sheet metal plant known as the Kesselschmiede und Blechwalzwerk von Piedboeuf; Schlosser & Feibasch, makers of cranes and hoists; the Maschinenfabrik Wikschtröm & Bayer, makers of machines for the wire industries; the Rheinische Metalwaren und Maschinenfabrik, manufacturer of seamless drawn steel tubing; the Walzmaschinen-Fabrik Aug. Schmitz, manufacturer of rolling mill machinery, and other plants of less importance.

Moreover, Düsseldorf is the center of a great industrial district, all points of which may be reached by short journeys on the steam and electric railways that radiate in every direction. It is not far to the great Krupp works at Essen; the Deutsche Maschinenfabrik Akt. Ges., the Duisberger Maschinenfabrik J. Jaeger, and the Gebrüder Scholten, at Duisburg; the Rud. Meyer Akt. Ges. and Thyssen & Co., at Mülheim-am-Ruhr; the Maschinenbau Akt. Ges. Balcke, at Bochum; the Wilhelm Breitenbach Maschinenfabrik at Unna; Basse & Selve at Altona; Otto Froriep, at Rheydt; the Maschinenfabrik Sürth, Gas Motoren Fabrik Deutz, Kolnische Maschinenbau Akt. Ges., the J. Pohlig Akt. Ges., and Maschinenbau Anstalt Humboldt in Cologne and vicinity; the great steel works and machinery building plant at Oberhausen, called the Gutehoffnungshütte, a name that is said to be derived from the iron works at Sterkrade where the founder of the Krupp works learned his trade; and other establishments along the route. In addition there are Dortmund, Gelsenkirchen, Hagen, Hamm, Horde, Remscheid, München-Gladbach, Solingen, Eberfeld-Barmen, Neuss, Mülheim-am-Rhein and perhaps Aachen, the farthest to the West, all of which will repay visits if a traveler has the time.

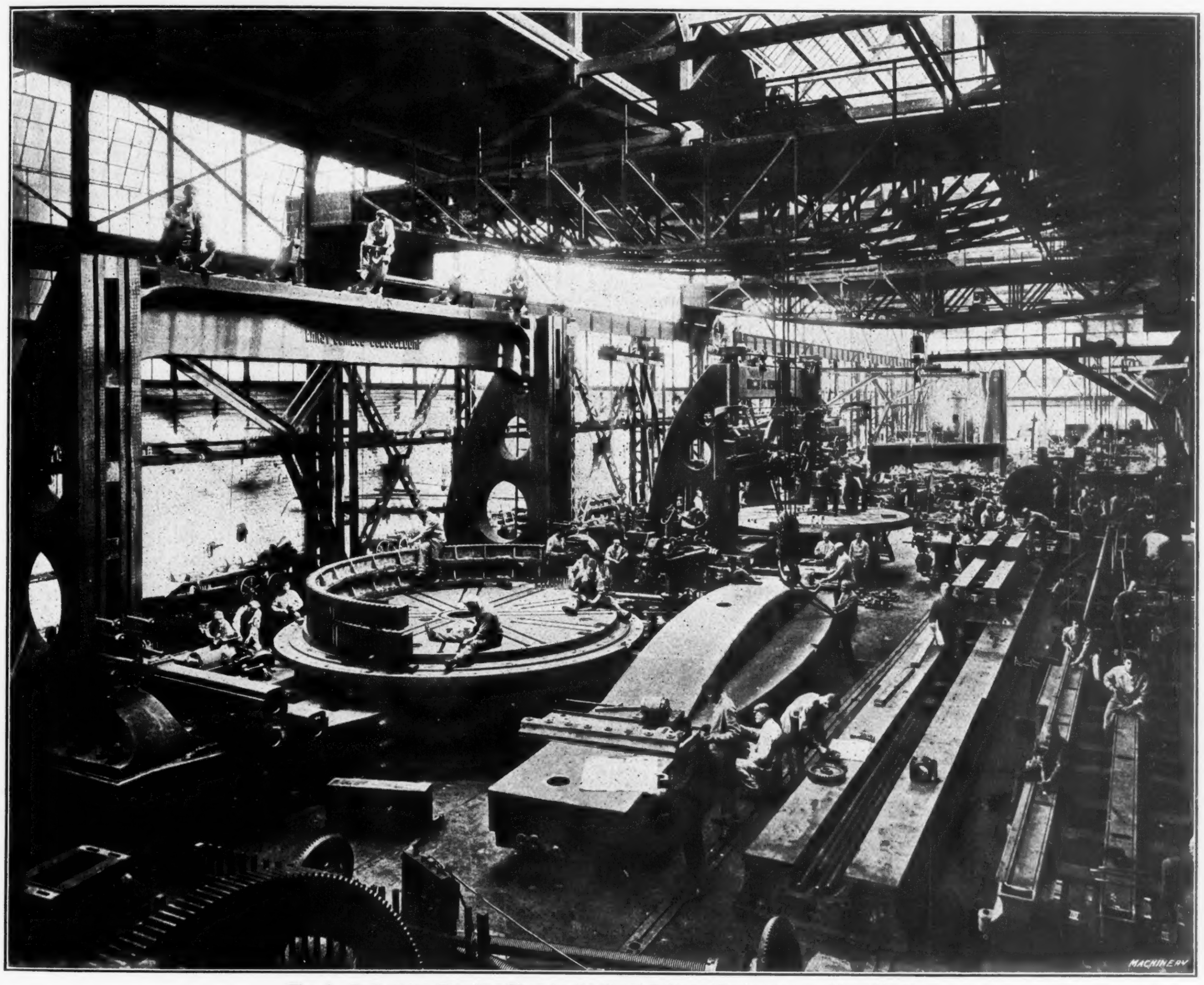


Fig. 4. Part of the Erecting Shop in the Ernst Schiess Werkzeugmaschinenfabrik

Düsseldorf now has a population not much under that of Cincinnati. It is a fine modern city, the seat of the provincial council, with wide, well-paved streets, a good harbor, beautiful parks, and public utilities of every description. As a pleasant, comfortable place in which to live, it has attracted the best classes of labor, not only from other parts of Germany but also from neighboring countries. The value of this condition as an asset both of the present and future is fully appreciated by the manufacturers mentioned, who are cooperating in every possible way to perpetuate it. Conditions such as those in Pittsburg, and which other American machinery centers are rapidly approaching, will, if the present policy is maintained, never be known in Düsseldorf, the busy, hospitable city on the Rhine.

NOISY GEARING*

ITS CAUSES AND A METHOD OF CORRECT DESIGN FOR ITS ELIMINATION

By E. A. VESSEY† and J. A. SEAGER‡

A great deal has been written on the subject of noisy gearing. Many suggestions have been made for its elimination and some improvements have undoubtedly been made. In the present article a method will be explained which tends to produce silent-running gearing. This method has been practically applied by one of the writers for several years.

Causes of Noisy Gearing

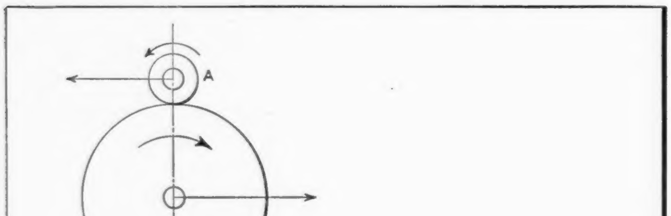
All noise in gearing is caused by the vibration of the material in the gear. The source of this vibration is usually a series of blows resulting from one or more of the following causes:

1.—The individual teeth are unequally loaded; that is, the load is borne by more teeth at some periods than at others. In this case it is perhaps incorrect to describe the effect on the teeth as a blow, since it takes the form of an increased compression of the material, which, however, produces vibration.

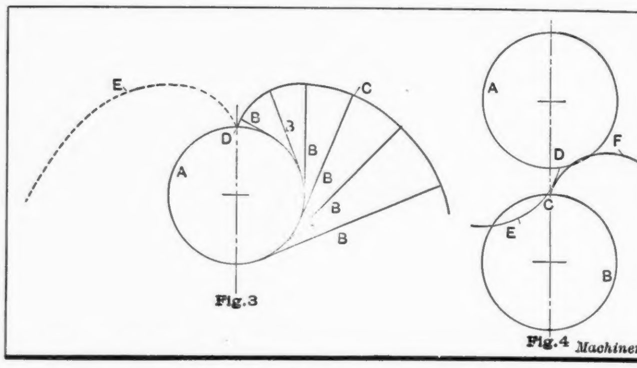
2.—The blow may be an actual concussion caused by one tooth being disengaged before the next tooth takes up the load. Under present conditions this is a cause seldom met with, but was often found in the past when pinions with too few teeth were used.

3.—Owing to inaccuracies in cutting, the pitch of the teeth may vary around the gear circumference, so that while theoretically two or more teeth should be in contact, only one supports the load. When the latter comes out of contact, the load is transmitted to the next tooth by a sharp blow. This has been a most prolific cause of noisy gearing.

4.—The faulty alignment of the shafts on which the gears are mounted produces a jamming action, causing an objectionable grinding noise. Even if the alignment is perfect when the gears are erected, the shafts are practically certain to become displaced sooner or later owing to uneven wear in the bearings. Figs. 1 and 2 show, diagrammatically, a case of this kind. In Fig. 1 the power is transmitted from pinion *A* to gear *B*. Assume that the action between the teeth is perfect and that, therefore, the pressure between the teeth is at all times in exactly the same direction relative to the pitch circles. This pressure tends to force *B* in the direction of the lower horizontal arrow and *A* in the opposite direction. Actual motion is prevented by bearings *C* placed as close to the gears as possible, but, in time, the pressure on the bearings *C* will cause wear; if the bearing surface is inadequate, which is commonly the case, perceptible wear soon takes place. The result is that the shafts *D* tend to turn bodily about their bearings at *E* where the wear is not likely to be so pronounced. The gears then take a position as indicated in Fig. 2 and the teeth will bear on both sides. This is undoubtedly the reason why gears originally silent in action, gradually become noisy. This defect is difficult to cure entirely, but a great deal may be done by increasing the available bearing surface close to the gears, or by placing another pair of bearings outside of the gears. Of course, the forces acting on the bearings are not horizontal, but slightly inclined, owing to the inclined action on the teeth. For simplicity of illustration, however, the case has been presented as indicated.



Figs. 1 and 2. Diagrammatical View showing Effect of Disalignment



Figs. 3 and 4. The Involute Curve and its Application to Gear Teeth

5.—Noises are also due to special forms of teeth. For example, with cycloidal teeth, the smallest separation of the shafts destroys the uniformity of transmission and noise results. Since, however, the involute tooth is now practically universally adopted, the present article will deal with the latter form of tooth only. The statement that a partial separation of the centers of involute gears does not affect the true working of the teeth is not wholly true; cases may occur when noise will result from this cause. A separation of the centers has the effect of reducing the length of time of contact, and hence it is reasonable to assume a case when two gears have such a number of teeth that one tooth is released from the load at the instant when the next tooth in succession comes into mesh. In this case the conditions mentioned under (2) are met with.

6.—Interference between the teeth themselves is a common cause of noisy gearing. To rightly understand this cause it is necessary to enter briefly into the theory of the shape of the involute tooth. The involute is commonly defined as a curve described by the end of a string as it is unwound from a cylinder, the string being kept taut, so that in every position it may be described as a tangent to the cylinder. In Fig. 3, *A* represents the cylinder and *B* the string in various positions as it is unwound from the periphery of *A*; *C* is the involute described by the end of the string. The circle *A* is known as the "base circle" of the involute, and *D* is called the "source of the curve." It follows from the definition that the involute is not a closed curve; in other words, it terminates in infinity. It is also evident that it is a curve of two branches because the string may obviously be unwound from the "base circle" in either a clockwise or a counter-clockwise direction, the second branch being indicated in Fig. 3 by the dotted curve *E*. As the involute lies entirely without the circumference of its base circle, the working part of the curve terminates at *D*. It is, therefore, evident that we must so proportion the mating involutes that when the two curves are rolling together, the point of contact between the source of one curve with the other curve shall be the outer termination of the latter.

This will be made clearer by referring to Fig. 4. Here *A* and *B* are two base circles with their respective involutes *E* and *F*; *D* is the source of *E*, and *C* of *F*. The two involutes are in contact, and it will be seen at once that the involute *E* must be cut off at the point which has been in contact with *C*, and similarly that *F* must terminate at the point which will come ultimately into contact with *D*. If the involutes are extended beyond these points, the mathematical action still continues but actual contact is impossible, since it entails an overlapping of the curves, causing one tooth to dig into

* For information along similar lines previously published in MACHINERY see: "Interchangeable Involute Gear Tooth Systems," January, 1909.

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the other. The points C and D, are known as "interference points," and interference or the digging of one tooth into its mate is a direct result of extending the addendum beyond the circle drawn through the interference point.

Evidence that interference actually occurs in practice will usually be found on examining a pair of gears which have been in action for some time and where one of them is a pinion of less than 20 teeth. On examining the pinion teeth, a groove will be found in the face of the teeth, slightly below the imaginary pitch line of the tooth, and the points of the gear teeth will be found to be rounded over and bright. In some cases this groove becomes a keen line, as if it had been drawn with a scriber. Except in the case of equal gears, the groove is usually found only on the teeth of the gear with the lesser number of teeth. The presence of this mark is invariably accompanied by noise, and is a sure sign of their being too few teeth in the pinion. It is proposed to deal more fully with this point later, since it deserves a great deal more attention than it generally receives. The blow which causes vibration and noise in this case takes place between the points of the gear teeth and the flanks of the pinion teeth. On first contact, it is a blow pure and simple, afterward becoming an abrasion, so that from this cause two distinct kinds of noises arise, namely, the ring due to the blow and the grind due to the abrasion. Noisy gears must of necessity be ineffi-

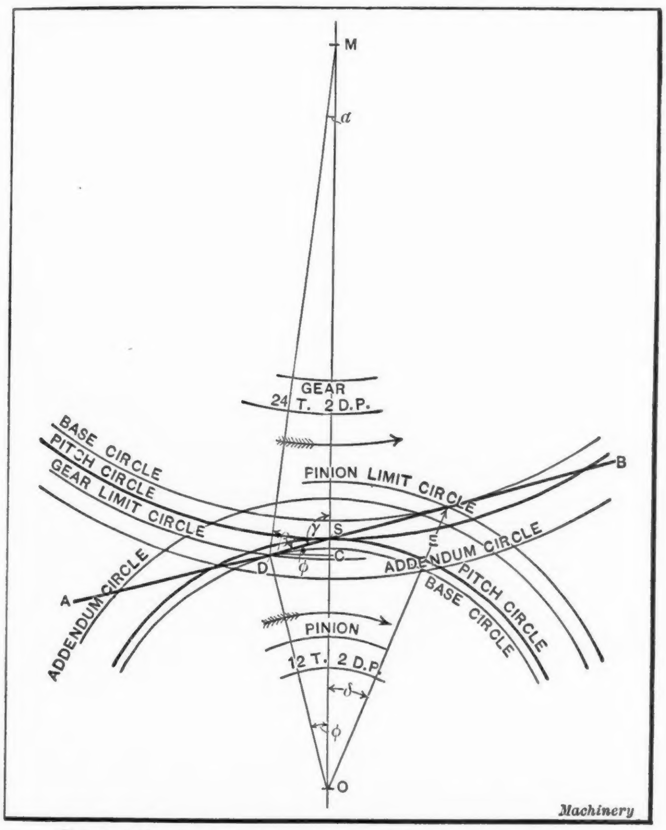


Fig. 5. Diagrammatical Lay-out for the Derivation of Formulas

cient transmitters of power. Therefore, altogether apart from the question of comfort, noise must be reduced as far as possible if high efficiency is to be attained.

The foregoing paragraphs give the six chief causes of noise in gearing. In the cutting of gearing by the various processes now in use, the limit of refinement in workmanship has practically been reached. It is therefore evident that in order to eliminate the noise of gearing, it is necessary to make a change either in the design of the teeth or in the gears themselves. One method which has been adopted for the reduction of noise is the use of pinions made of rawhide, paper, fiber and other similar materials. Gears made from these materials, however, do not remove the cause of the trouble, but merely allay it, and the very causes which produce the noise in regular gearing in most cases end by destroying the pinion when made from less wear-resisting materials. In the writers' opinion, the materials mentioned, by their very nature, do not always promise good wearing resistance—with the exception probably of fiber. Besides, other troubles are introduced: rawhide is easily injured by oil, and the same applies to paper pinions; consequently lubrication is difficult, it becoming necessary to use solid lubricants, which are somewhat difficult to apply. Fiber is peculiarly susceptible to moisture, which causes it to swell and often to jam. These materials for gearing cannot, therefore, be considered a permanent aid for securing efficiency of transmission.

Noise due to Interference—Analysis of the Conditions

It has already been shown that for any two gears in mesh, owing to the nature of the involute curve, interference points exist, and that if circles are drawn through these points, the points of the teeth must not be prolonged beyond these circles. This being so, we are led to believe that, given a ratio, there should be one pair of diameters which will give the best results, and one pair only. It is proposed to prove that such is actually the case, and to proceed to establish formulas which will enable us to fix the correct number of teeth in the larger gear of a pair for any ratio. The present article has been written particularly with the object of bringing this important matter before the practical man.

In Fig. 5 is shown, diagrammatically, a pair of gears, and the number of teeth has been purposely chosen very low in order to render the argument more obvious. The tooth profiles are assumed to be involutes and hence the line of contact is a straight line AB. The base circle (that is the circle from which each involute is generated) is marked for each gear. Now, the limit line for each gear is found by striking from the gear center an arc passing through the point of tangency of the line of contact AB and the base circle of the other gear (*i. e.* the source of the working involute). These points are D and E, respectively, and the limit circles are shown passing through them. It will at once be seen that as far as the pinion is concerned, no interference is to be anticipated, since the addendum circle lies well within the limit circle, but a considerable shortening of the addendum of the wheel teeth is necessary if interference is to be avoided. The addendum is usually taken as a function of the pitch, the value most commonly used being:

$$\text{Addendum} = \frac{1}{\text{diametral pitch}}$$

It will, therefore, be seen that if standard teeth are to be used, it is necessary to redesign the gears, adjusting the number of teeth and pitch so that the addendum circle and limit circle shall at least coincide. The best conditions are secured when these two circles coincide because the maximum arc of contact without interference is then obtained. Further, it is obvious that since the height of the teeth in the larger gear is dependent on the point of tangency of the line of contact and the base circle of the pinion, any variation in the ratio of the train by altering the pitch diameter of the pinion, and consequently also its base circle diameter, will entail an alteration in the tooth height for the gear; in other words, there is for every ratio one pair of gears, and one only, which will give the best all around efficiency.

The requirements are filled when the first point of the contact of the gear (the intersection between the line of contact AB and the addendum circle) is so located that a radius from the center of the pinion, through this point, makes a right angle with the line of contact. In that case, the addendum circle and the limit circle of the gear will coincide.

In Fig. 5 let angle SDO be a right angle, and let the angle SDC of the involute be called ϕ. The line CD is perpendicular to line MO, the line through the gear centers. Then, angle SOD = angle $SDC = \phi$

Let $SD = a$, and $SC = x$. Then, $\frac{x}{a} = \sin\phi$ (1)

Let n = number of teeth in pinion,
N = number of teeth in gear, and
P = diametral pitch.

Then, $SO = \frac{n}{2P}$, and $\frac{SD}{SO} = \frac{a}{n \div 2P} = \sin\phi$ Hence,

$$a = \frac{n}{2P}\sin\phi \qquad (2)$$

Substituting in (1) and transposing:

$$x = \frac{n}{2P} \sin^2 \phi \qquad (3)$$

In triangle CDO we have $\frac{CD}{CO} = \tan \phi$. But,

$$CO = SO - SC = \frac{n}{2P} - \frac{n}{2P} \sin^2 \phi = \frac{n}{2P} \cos^2 \phi$$

Hence,

$$\tan \phi = \frac{CD}{\frac{n}{2P} \cos^2 \phi} \qquad (4)$$

Let angle $CMD = \alpha$; Then, $\tan \alpha = \frac{CD}{CM} = \frac{CD}{SM + SC}$

But $SM = \frac{N}{2P}$. Hence,

$$\tan \alpha = \frac{CD}{\frac{N}{2P} + \frac{n}{2P} \sin^2 \phi} \qquad (5)$$

Dividing (4) by (5):

$$\frac{\tan \phi}{\tan \alpha} = \frac{N + n \sin^2 \phi}{n \cos^2 \phi} = \frac{N}{n \cos^2 \phi} + \tan^2 \phi. \text{ Hence,}$$

$$\cot \alpha = \frac{N}{n \sin \phi \cos \phi} + \tan \phi \qquad (6)$$

from which α can be determined.

We have further, $\alpha + \beta + \gamma = 180$ degrees. But $\gamma = 90° + \phi$.

Therefore, $\beta = 90° - \phi - \alpha$ (7)

from which β can now be found. Further,

$$\frac{DM}{\sin \gamma} = \frac{SM}{\sin \beta}$$

But $DM =$ half the outside diameter of the gear $= \frac{N+2}{2P}$

$SM = \frac{N}{2P}$ and $\sin \gamma = \cos \phi$. Hence,

$$\frac{N+2}{2P \cos \phi} = \frac{N}{2P \sin \beta}$$

$$\sin \beta = \frac{N}{N+2} \cos \phi \qquad (8)$$

As β is known from Equation (7), N can be obtained by solving (8). The value of N thus found is the smallest number of teeth permissible in the larger gear if interference is to be entirely eliminated.

Charts for Finding Number of Teeth in Large Gear

The foregoing solution appears cumbersome, but in applying it to practice the only equations used are (6), (7), and (8), which are easy to solve. The curves corresponding to the equations for 14½- and 20-degree angles of involute are given in Figs. 6 and 7. One curve in each chart was arrived at by solving Equation (8) and was plotted with values of $\sin \beta$ as abscissas and corresponding values of N as ordinates. From Equation (6) values of $\cot \alpha$ were then found corresponding to given values of $\frac{N}{n}$ (the ratio). Knowing α and ϕ, values of β were then obtained from (7) corresponding to the given values of $\frac{N}{n}$. Corresponding values of $\sin \beta$ were then found from a table of sines, and the second curve was plotted with $\frac{N}{n}$ as ordinates, and the value of $\sin \beta$ as abscissas. The dotted lines on each chart indicate the course to be traced in using the diagram. The most usual problem will be, given a ratio, to find the most suitable number of teeth for the larger gear. In solving this problem, first find on the left-hand side of the chart a figure denoting the given ratio, and trace horizontally to meet curve marked "Curve I." From this point trace vertically to meet "Curve II," and then again horizontally to the right-hand side of the chart, where the correct number of the teeth for the larger gear will be found. Thus in the example chosen it was required to find the correct number of teeth in the larger gear of a pair having a ratio of 5 to 2. This ratio is first expressed in terms of unity, *viz.* 2½ to 1, and 2½ is found on the left-hand side of the chart. The dotted line is then followed horizontally to Curve I, and then vertically to Curve II, and finally horizontally to the right side of the chart. In Fig. 6, for 14½-degree involute, the number of teeth is found to be 65, and in Fig. 7, for 20-degree involute, 38. The pinions then will have 26 and 15.4 teeth, respectively. Since fractional teeth are impossible, these values for the pinions become 26 and 16, and, therefore, the corresponding gear teeth values are 65 and 40.

For the moment, since 14½ degrees has been practically universally adopted as the standard angle of involute, our attention will be confined to Fig. 6. Two things are particularly to be noticed:

1.—As the ratio increases, the number of teeth in the pinion must also increase. Thus with a ratio of 1 to 1 (equal gears) both gears should have 22 teeth; with a ratio of 4 to 1 the pinion must have $118 \div 4 = 30$ teeth; and with a ratio

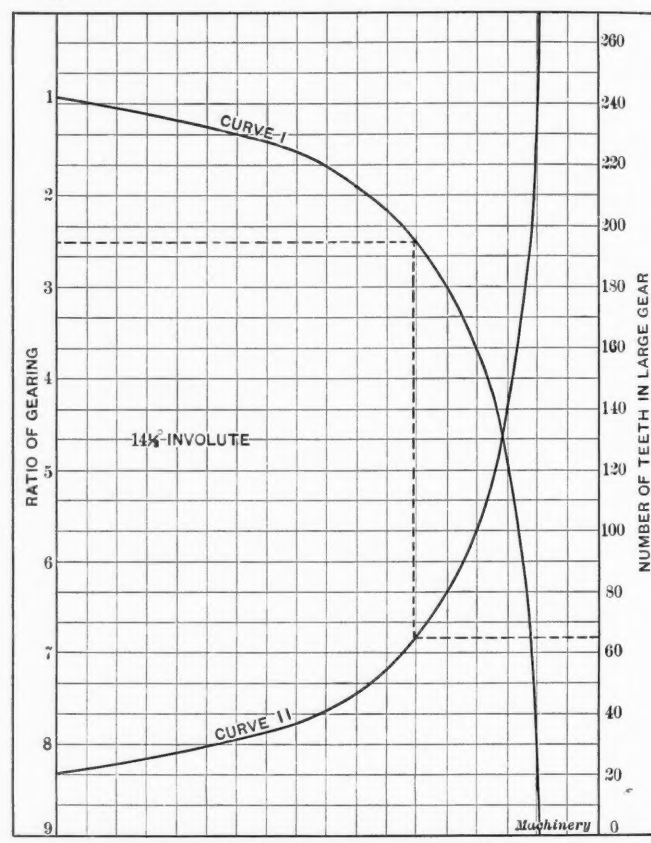


Fig. 6. Chart for Finding Smallest Number of Teeth in Large Gear for Given Ratio with 14 1/2-degree Pressure Angle

of 8 to 1 the value must be increased to $250 \div 8 = 32$ teeth.

2.—The number of teeth in common use for pinions is as a general rule far too small, especially for the high ratios.

Possible Methods for Avoiding Interference

The significance of these two points is very great. A reference to recent specifications for gearing will show that to a certain extent this principle has been grasped, but has not been carried sufficiently far. Probably the greatest field at the present day for gearing is in the transmission of power from electric motors, and it is here that the tendency to increase the number of teeth in the gears is most evident. Large gears with teeth of fine pitch and wide faces are used, but it is doubtful whether the slight advance which has been made in this direction has had any very appreciable effect in reducing the noise from the gearing. There are two reasons why the difficulty cannot be wholly dealt with by adopting finer pitches in order to increase the number of teeth:

1.—From consideration of strength, if fine pitches are used, the gear face must be correspondingly increased. Until quite recently face widths used to be from 2½ to 3 times the circular pitch, but now it is not at all uncommon to find 5 or 6 times the circular pitch used. With such relatively wide faces extreme accuracy in erection is necessary in order to secure an equal bearing all along the tooth face. Equal accuracy in the cutting is also most important. If this accuracy does not

obtain, the whole load is thrown on the corner of a tooth, and since the pitch is small, breakage is extremely likely to occur. Wear in the bearings will have the effect described under cause (4) at the beginning of this article.

2.—High ratios are, at any rate with electric motors, a necessity, if first cost of installation is to be kept down. Now, if the correct number of teeth is used in the pinion, the number of teeth in the gear becomes so great that difficulties are experienced in the cutting. Even on the hobbing machine, the time taken by the hob in traversing the circumference of the wheel is considerable, and on this account there is strong reason to believe that local heating of the blank is introduced with consequent errors of pitch. Such errors may undoubtedly be reduced to a minimum, but the cost of production is thereby considerably increased.

These two objections have obviously been raised by the practical man, and he alone has set the limit for the number of teeth which are practically advisable. Indeed, it is only with the aid of great persuasion that he has been induced to go so far as he has. Fine pitches do not "look right," and with the born engineer that is everything. He recognizes of course that silence is important, but if it is only to be obtained by the adoption of finer and still finer pitches, he begins to wonder if the game is worth the candle. Consequently if it can be shown that we may, by following certain simple rules, return once more to the coarser pitches and secure even greater degrees of silence than has so far been obtained by the use of the finer pitches, a great deal has been done to successfully solve this problem.

It is evident from **Fig. 7** that one way of reducing the number of teeth required for efficiency, is to increase the angle of the involute. Thus with a 20-degree involute, a 16-tooth pinion may be used with a 5 to 2 ratio, as compared with a 26-tooth pinion with a 14½-degree involute. This looks promising, and in some cases has been adopted, but it is an unfortunate fact that involutes of a given angle of obliquity will work only with others having the same angle; consequently 20-degree involutes will not work with the standard 14½-degree

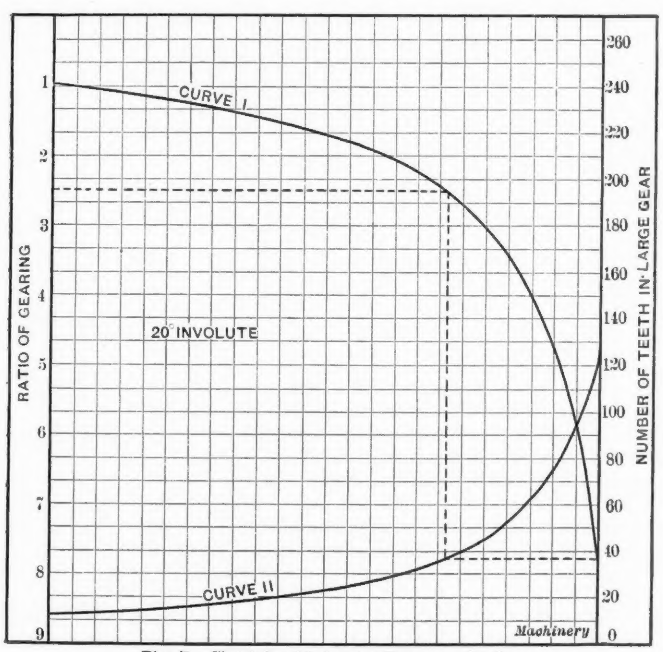


Fig. 7. Chart for 20-degree Pressure Angle

involutes. It, therefore, will be seen that confusion is likely to result from varying the angles, and in any case, the greater advantage of interchangeability is sacrificed. Another great objection to the adoption of increased pressure angles is that owing to the greater inclination of the path of contact, the pressure tending to force the gear teeth out of mesh is greatly increased; in other words, gears with teeth of high obliquity crowd on their centers to a considerably greater degree than those with smaller angles. On the whole it, therefore, appears that this method of arriving at the required result is not advisable.

Proposed Method—The Shortened Addendum

The method which the writers suggest, and which has been used by one of them in everyday practice with marked success for several years, may be set out as follows:

Interference, when present, is due to the addendum of the teeth in the larger wheel being prolonged beyond the limit circle; therefore, it seems logical to reduce the addendum by the amount it projects beyond this circle. It is, of course, necessary to see whether by so doing any objectionable features are introduced. A point which appears at once is that by shortening the teeth the duration of contact between two teeth is apparently shortened. As to whether this is a fact or not there seems to be very considerable doubt, but it is not proposed to enter fully into this question at this time since the investigation is somewhat lengthy. Admitting for the sake of argument, however, that the duration of contact is decreased, the important question now to consider is whether the shortened duration of contact is such as to cause one tooth to come out of mesh before the next one is engaged. Referring to Fig. 5 it has been shown that

$$\cot \alpha = \frac{N}{n \sin \phi \cos \phi} + \tan \phi \qquad (6)$$

By the same process it may be shown that if the angle SOE is called δ, then $\cot \delta = \dfrac{n}{N \sin \phi \cos \phi} + \tan \phi$

Now, in Fig. 5, $n \div N = \frac{1}{2}$, and ϕ is 14½ degrees. Hence, $\cot \delta = 2.3206$, and $\delta = 23$ degrees 19 minutes.

Angle $SOD = \phi = 14$ degrees 30 minutes. Hence angle DOE $= 37$ degrees 49 minutes.

This angle may be taken as a measure of the angular duration of contact. Around the circumference of the pinion there are twelve teeth and twelve spaces. It therefore follows that

$$\frac{37.82}{360} = \frac{x}{12}$$

where x equals the number of teeth always in mesh. In the present case x equals 1.26. Hence it will be seen that even in the extreme case chosen, one tooth will not come out of mesh before the next one is engaged.

The question of whether the life of the teeth is shortened should also be considered. In this connection it is necessary to point out that the action between teeth of true involute profile is only a true rolling action when the teeth pass the pitch point S, Fig. 5. At any other points in contact there is more or less slipping between them, the maximum being reached at the points of first and last contact and the minimum at the pitch point. When the teeth first make contact they approach each other obliquely, and even if interference is absent, the slipping is very great and causes wear. If interference is present, the effect is greatly aggravated. It, therefore, would seem that by removing the point of the tooth, the life of the gear is actually prolonged and this deduction is amply borne out in practice. Having disposed of the objections, the following rule may be enunciated:

When it becomes necessary to use a smaller number of teeth than that indicated by the chart, interference may be avoided by reducing the addendum of the teeth in the larger gear to what it would be if the number of teeth found from the chart were used.

For instance, suppose that the number of teeth given by the chart is 180, and that the required diametral pitch is 6. The pitch diameter would be 30 inches and the addendum 1/6 inch. Suppose also that 120 teeth is the largest number permissible. The diameter being as before 30 inches, the diametral pitch would have to be 4, the standard addendum being ¼ inch. With this gear, interference would occur, but if according to the rule, the addendum be reduced to 1/6 inch, no trouble would be met with. The actual reduction in diameter is given by the formula:

$$A = 2\left(\frac{N - T}{P \times N}\right)$$

where A = amount by which the over-all diameter of the gear is reduced,

N = number of teeth, found from chart,

T = number of teeth actually used,

P = diametral pitch actually used.

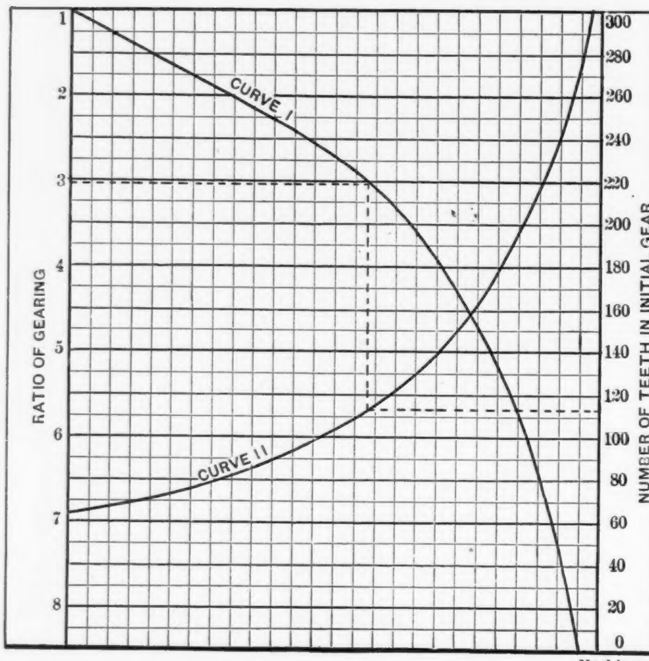
In the above example we have:

$$A = 2\left(\frac{180 - 120}{4 \times 180}\right) = \frac{1}{6}$$

which agrees with what has previously been said.

When carrying out this method in practice difficulties may be anticipated from cutting the teeth if the gear has been previously reduced in diameter; but it must be borne in mind that the reduction in diameter is a known quantity and, hence, can easily be allowed for when calculating the depth of the cut. If difficulties are experienced, the gears may be left with standard outside diameters until after the teeth are cut, when they may be reduced the required amount in the hobbing machine itself.

When giving this method a trial, it is not advisable that experiments be made on gears that have already been in use, because if wear has taken place the results may be most misleading. The probability is that a great improvement will be noticed in the running; indeed, the writer who has tried it has never yet found a case when the noise has not decreased; but if wear has taken place to any extent, other conditions are met with, and the trial may prove misleading. To get a fair idea of the results obtained by this method, a pair of gears with a ratio of 3 or 4 to 1 should be made, the pinion having 12 or 14 teeth, and with all dimensions standard. Another pair should then be made precisely similar, except that the diameter of the larger gear should be corrected as suggested; the two pairs should then be carefully erected and run side by side and the difference noted.



Machinery

Fig. 8. Chart for Internal Gearing, 14 1-2-degree Pressure Angle

It may be pointed out that since the addendum of the gear tooth has been reduced, the flank space of the pinion may be to a corresponding extent filled in, thus shortening the pinion tooth and thereby reducing the under-cut and greatly increasing the strength of the tooth. This can only be done by using a special hob or cutter with shortened teeth, and unless a large number of duplicate gears are to be cut, the expense is not warranted.

It should be pointed out that if the gear ratio is one to one (equal gears), and the number of teeth to be used is less than the number found from the chart, it will be necessary to shorten the teeth of both gears. This being so, we are led to suppose that possibly with other ratios it may become necessary to reduce the height of the pinion teeth, if a low number of teeth is used. Such is the case in practice, and it may be demonstrated by a construction for the pinion simliar to that given in Fig. 5 for the gear. This correction of the pinion may be necessary with ratios from 1 to 1 up to 3 to 2, but since the ratios between these limits are less often used, it has not been thought necessary to give specific formulas.

Application to Rack and Pinion, Worm Gearing, and Internal Gears

The principle may be applied to rack systems in which case it can be shown that to avoid interference:

$$\frac{n-2}{2}\tan^2\phi = 1$$

in which n = the minimum number of teeth in the pinion,
ϕ = the pressure angle in degrees.

Solving this equation for $\phi = 14\frac{1}{2}$ degrees, we obtain n = 31.86 or 32 teeth. A smaller number of teeth may be used, provided the rack teeth are shortened in a similar manner to that described for external gears.

If x = the amount to be cut off the rack teeth,
N = the number of teeth to be used in the pinion,
ϕ = the pressure angle, and
P = the diametral pitch,
then it may be shown that

$$x = \frac{2 - N\sin^2\phi}{2P}$$

It will be noticed that if N is made = 31.86, and $\phi = 14\frac{1}{2}$ degrees, the numerator of the fraction vanishes, whence x = 0, which agrees with what has previously been said.

It is obvious that when dealing with the rack and pinion we have also disposed of the worm and worm-wheel. It follows that if interference is to be avoided, a worm-wheel should never have less than 32 teeth. Incidentally, it may be suggested that this probably explains why worm-wheels with a small number of teeth frequently run hot in spite of the fact that they are only lightly loaded.

One other case remains to be dealt with, *viz.*, the internal gear. It has so frequently been shown that there is a certain minimum allowable difference between the numbers of teeth in the pinion and the mating internal gear that it is only necessary to mention it in passing, and to say that the interference which occurs if this rule is infringed upon is entirely separate from the interference dealt with throughout this article.

The argument already presented for spur gears may be equally well applied to internal gears. As with the spur gear, a similar line of argument results in three formulas which naturally bear a strong resemblance to formulas (6), (7) and (8).

$$\cot\alpha = \frac{E}{\sin\phi\cos\phi} - \tan\phi \qquad (9)$$

$$\beta = 90^\circ + \phi - \alpha \qquad (10)$$

$$\sin\beta = \frac{N}{N-2}\cos\phi \qquad (11)$$

where E = the ratio of the train,
ϕ = the pressure angle,
N = the number of teeth in the internal gear which gives the best all around results for that particular ratio.

The chart shown in Fig. 8 combines these formulas and puts them into a convenient form for use. A smaller number of teeth than the number found from the chart may be used, and interference is avoided as before, if the internal teeth are shortened. It must be noted that shortening the teeth in this case has the effect of increasing the internal diameter of the gear blank, the increase in bore being equal to

$$2\left(\frac{N-T}{PN}\right)$$

in which N = the charted number of teeth in the wheel,
T = the actual number of teeth used,
P = the actual diametral pitch.

In conclusion it may be pointed out that a similar line of reasoning may be applied to bevel gears, which in extreme cases may need correction for interference. It is hardly necessary to state that the actual numbers of teeth in the gears must not be used in applying the formulas, but that for these values must be substituted the developed numbers of teeth obtained in a manner well known to all designers.

* * *

It has never been proved that copper was hardened by the ancients, although one frequently hears statements made to that effect. Most of the copper implements that have been supposed to have been hardened are merely alloys of copper and tin. Other implements of pure copper have been given firmness by hammering or "cold-working," as it is frequently called. Both of these two processes are well-known to-day, and by no means constitute a lost secret of the past.

THE ROSS RIFLE AND ITS MANUFACTURE—2

THE PROCESSES EMPLOYED IN THE MANUFACTURE OF A MILITARY RIFLE OF UNIQUE DESIGN

By DOUGLAS T. HAMILTON*

The production of a high-grade military rifle presents some unusual difficulties in interchangeable manufacture, on account of the stringent requirements which must be met. It is absolutely necessary that it be manufactured from the best materials obtainable, be of first-class workmanship, of simple design, easily and quickly operated, and also be able to withstand reasonable wear, without getting out of order.

The chief difficulty, however, which confronts the designer and manufacturer is that of producing the rifle within the limited cost at which it must be manufactured. However, with an efficient machine- and tool-equipment, it is possible by careful and scientific management to produce a military rifle at a reasonable cost which will meet these requirements. The methods employed by the Ross Rifle Co., of Quebec, Canada, in surmounting these difficulties should be of more than passing interest to readers of MACHINERY. While the following description applies more particularly to the Mark II ** military rifle, it also covers the operations on the sporting rifles, with the exception of a few minor details.

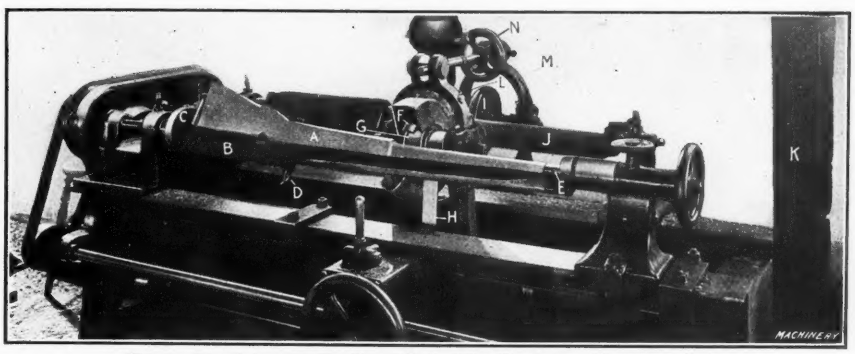


Fig. 9. Rough-turning the Front End of the Stock in a Blanchard Lathe

Turning the Wooden Stock

The wooden stock is made from selected black walnut, which is obtained from Italy, France and Roumania. The trees from which the stock is made are felled in the autumn, when the sap is down in the roots; then the wood is roughly cut into the form desired, examined for worms, gall, shakes and other defects, and stored to season for about three years. When received by the Ross Rifle Co., the stock closely approximates the shape required, but is of sufficient thickness to allow turning and roughing out in a general way. Before any work is done on the stocks they are again kiln-dried and seasoned for five or six months, so that any tendency to warp is practically eliminated.

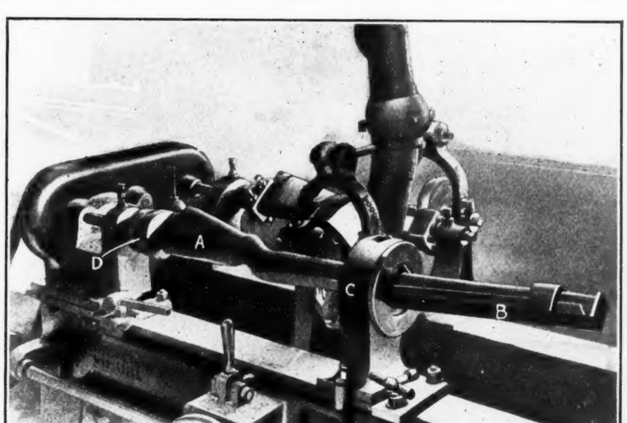


Fig. 10. Rough-turning the Butt End of the Stock

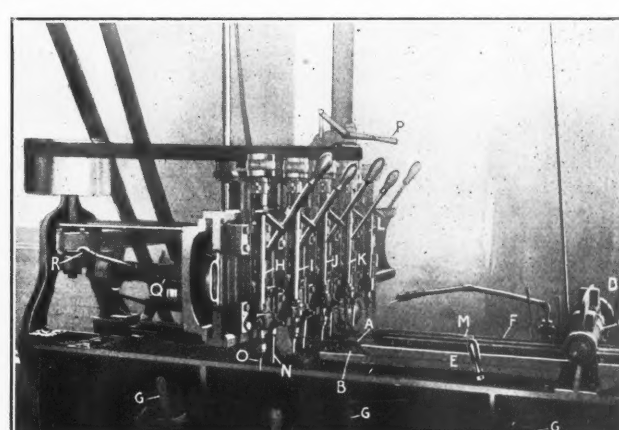


Fig. 11. Inletting for the Barrel, Receiver, Magazine and Spring Clips

The first operation on the stock is to plane both sides, to show up the grain and to expose any defects that cannot be seen when in the rough condition. The stocks are then "grained" or graded, those having the prettiest and most perfect grain being selected for the most expensive rifles. After planing, a saw slot is cut in the butt end to facilitate driving when turning. The stocks are then taken to the lathe shown in Fig. 9 where the front end of the stock is rough-turned. This interesting lathe originated in the Springfield Armory, and was designed by Thomas Blanchard in 1822. Previous to its invention, the gun stocks were cut out and finished entirely by hand. As the lathe was not patented, the English government, in 1855, obtained permission to inspect it and make drawings, which were later taken to the government shops at Enfield, England, where the lathe was then adopted. Of course, this lathe has changed somewhat from its original design, but it works on practically the same principle as the machine designed by Blanchard in 1822.

When ready for turning, the stock *A* is placed on the fixture *B*, and is held with a C-clamp *D*, the slot in the butt end fitting on a projecting member of the head *C*, while a pointed center *E*, operated by the handwheel shown, holds the fore part of the stock in position. The turning is accomplished by scooped cutters *F*, which are similar in shape to a carpenter's gouge; six of these cutters are held by cap-screws to the revolving head *G*. The cutter head is driven by a belt *H*, from a driving shaft underneath the machine, and is guided by the wheel *I*, revolving on a cast-iron dummy *J*. As the two brackets *L* and *M* are connected by a screw which has a right- and left-hand thread, any motion of the bracket *M* is transmitted to the bracket *L* in which the cutter head *G* is held. The iron dummy *J* is made of the required shape, and revolves at the same rate of speed as the bracket carrying the stock, the dummy *J* and the bracket *B* being connected through spur gearing. Power is transmitted to this machine through a belt *K*.

The longitudinal feeding of the cutter head is similar to that of the ordinary lathe. Of course it is evident that the cutter head and the bracket holding the wheel *I* travel along at the same rate of speed. The handwheel *N* is used for governing the "diameter" of the stock; by drawing the brackets together the "diameter" is increased, while by moving them apart it is decreased. The time required to rough-turn the front end of each stock is three minutes and ten seconds.

The stock is now taken to the Blanchard lathe shown in Fig. 10 where the butt end is turned. Here the stock *A* is held in a fixture *B* which is free to rotate in the head *C*, being clamped by a clamp, operated by a wrench which passes down through the hole shown in the revolving head. Before clamping, the stock is located in the correct position against the head *D*. The same type of turning tools is used, and the time required for rough-turning is two minutes, thirty-five seconds.

Inletting for the Barrel, Receiver, Magazine and Trigger Guard

Before finish-turning, the stock is taken to the machine shown in Fig. 11 where it is cut out for the reception of the barrel and receiver. This machine is called an "inletting" machine and works on the same principle as a profiling ma-

* Associate Editor of MACHINERY.

chine. After the stock A is placed in the fixture B, which clamps it down firmly, the groove for the barrel is cut. This is accomplished by means of six gouge cutters, three of which are held to the heads C and D, respectively. These heads are located on an arbor, and are moved in and out by means of guides E and F, fastened to the bed of the machine and set to the required taper. The heads C and D are kept apart by a spring, the cutters on one head overlapping those on the other. As the table holding the stock A is traversed to the right, the guides E and F draw the heads C and D together, which increases the overlapping of the cutters, thus gradually widening the slot.

After the groove is cut, the table is moved back by means of the handles G, to bring the stock under the cutters held in the five heads H, I, J, K and L. Each of these heads holds a cutter and pin, the latter operating in a profiling guide M, fastened to the bed of the machine. The former pins N are made to follow the outline of this guide, thus governing the movement of the cutters O. The guide is made of separate blocks of steel of varying thicknesses, so that the top of one guide acts as a stop for the depth of the cut. The various cutter spindles are brought into operation by moving the lever P, which throws the belt from the loose pulley onto the pulley on the cutter spindle.

The cutter in the first head is used for roughing the outside seat for the receiver; the second, for finish-shaping the

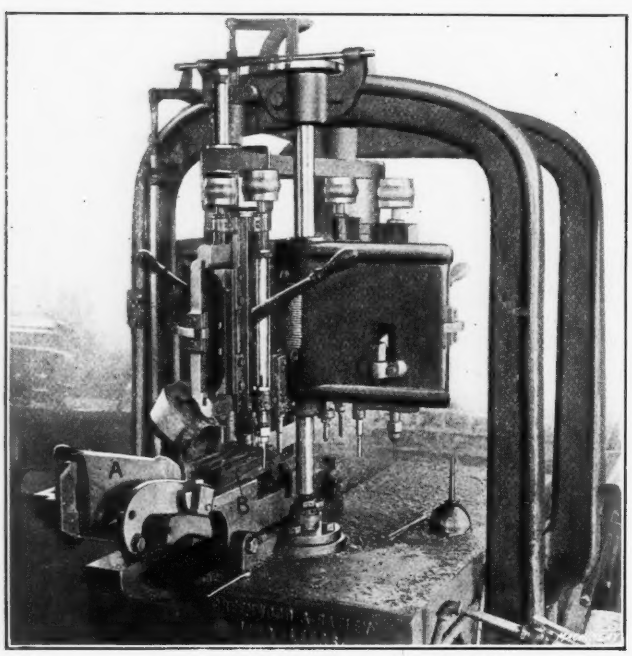


Fig. 12. Inletting for the Trigger Guard

seat; the third cuts the clearance for the finger piece; the fourth drills the holes for the bolt stops, and the fifth makes the clearance cut for the ejector. After these various operations have been accomplished, the bed of the machine is again shifted by moving the handles G, which brings the stock A under the revolving cutter arbor Q. This arbor holds cutters which finish out the radius for the receiver and the sight. The cutter head remains idle until the handle R is depressed, when, through a series of links, the belt at the rear is shifted from the loose to the tight pulley, thus revolving the head.

Before inletting for the trigger guard, the top face of the stock is milled as is also that part of the stock which is to be inletted for the trigger guard and magazine. The stock is then taken to the machine shown in Fig. 12, where it is clamped in a fixture as shown. This machine also works on the profiling principle; it consists of a revolving head carrying four sets of scooped cutters and former pins. The depth of the cut, in this case, is governed by stops placed on the former pins which come to rest on top of the profiling guide B. Two of the cutters are used for roughing and finishing the seat for the receiver, while the other two are for cutting the impression for the trigger guard.

Turning for the Bands and in between the Bands

The next operation is turning for the front and rear bands which hold the barrel to the stock. This is accomplished in the banding machine shown in Fig. 13. The stock A is placed in the revolving head B, and a clamp fitting in the space cut out for the magazine holds it firmly. This machine is provided with two swinging cutter heads C and D, to each of which six flat cutters are attached, the cutter heads being revolved by belts as shown. The stock when "banding" is rotated by means of the large handwheel E, which is revolved by hand. The guiding of these cutter heads so that the cutters form the correct shape is accomplished in a novel way.

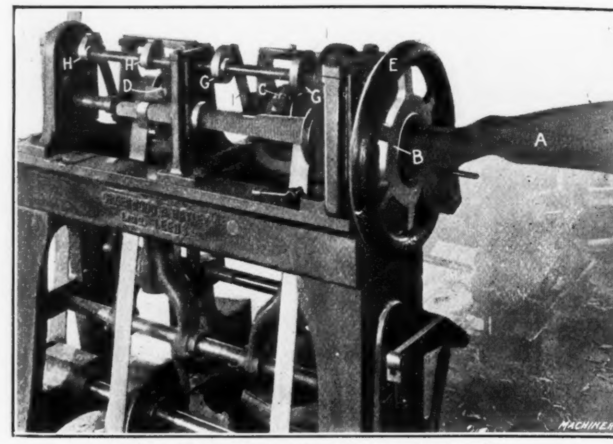


Fig. 13. Reducing the Stock for the Bands

A shaft running the entire length of the machine, carries four cams G and H, which are of the same shape as that required on the stock. This shaft is connected to the revolving head carrying the stock by spur gearing and is thus rotated with it.

In operation, as the cutter head C is brought up in contact with the stock, by operating the foot-lever, the square rods I are forced back by the cams G until they come in contact with set-screws which act as stops. Now upon turning the handwheel E, the head carrying the cutters is guided by these cams, and the cutters turn the stock to the required shape and size. The same operation is repeated for the front band, the other foot-lever being depressed to operate the head in a similar manner.

After turning for the bands, the stock is taken to the machine shown in Fig. 14, which is of similar design to that

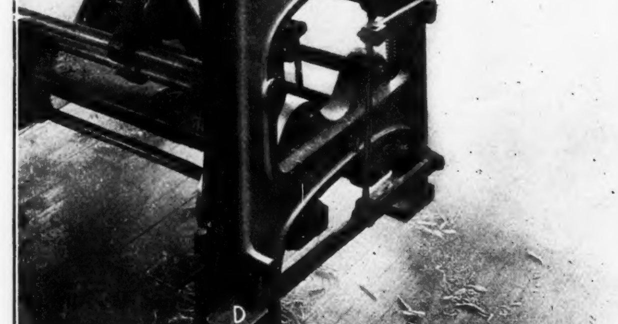


Fig. 14. Finish-turning between the Bands and Sandpapering

shown in Fig. 13, where it is placed in the revolving head B. A long brass casting C, somewhat the shape of a barrel, but which is cast with seats for holding twenty flat cutters clamped to it at intervals and overlapping each other, forms the cutter head. This revolving head C is brought into position by depressing the foot-lever D, and is guided by cams, as in the previous operation. After turning the fore end of the stock,

the other treadle is operated, thus bringing the sandpapering-wheel *E* into action, which is used for finishing. The sandpaper is held on a cast-iron drum, around which a band of felt, 3/8 inch in thickness, is wound, to prevent the sandpaper from stripping. The sandpaper is retained in position on this drum by means of a steel strip *F*, fastened with four screws as shown.

The stock is now taken to a Blanchard lathe where it is

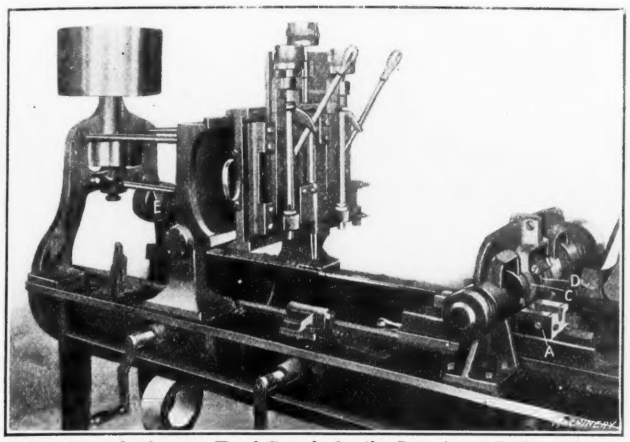


Fig. 15. Inletting the Hand Guards for the Barrel and Spring Clips

finish-turned its entire length, with the exception of that part which has been finished in the machine shown in Fig. 14. After this, the holes for the lifter screws are drilled, and the butt end is profiled. The 3/4- and 1/2-inch holes in the butt end are then drilled, and the milling for the butt-plate is accom-

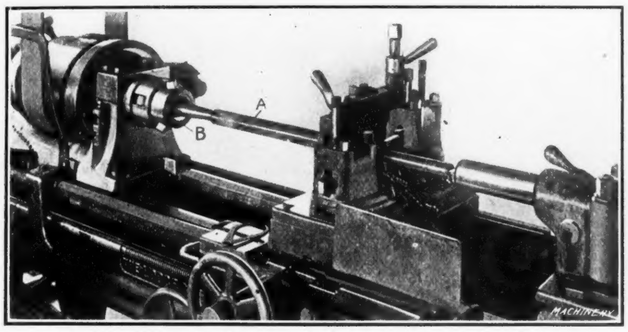


Fig. 17. Rough-turning Barrels in a Lodge & Shipley Lathe

plished. The fore end of the stock is now finished, and the slot cut for the lifter.

Upon the completion of the machine work, the stock is fitted to a gage of the same shape as the receiver, so that it will be flush with the receiver when assembled in it. The other parts of the stock which cannot be sandpapered in the machine are done by hand, and the stock as a whole is carefully inspected and "touched up." The stock for the sporting rifles—model E and the 0.280 Scotch deer-stalking pattern—are checked at the fore end or grip, and at the rear of the trigger guard, or "pistol grip" as it is called. This checking is done by hand; the operator lays off the design with a templet, and then with a small tool which is provided with two V-shaped projections, he cuts out the design. One of these V-shaped projections fits in the groove previously cut and acts as a guide. The object of the checking is to furnish a good grip, and it also adds considerably to the finished appearance of the stock. The stock is now ready for the finishing operation which consists of strapping and polishing, the polishing

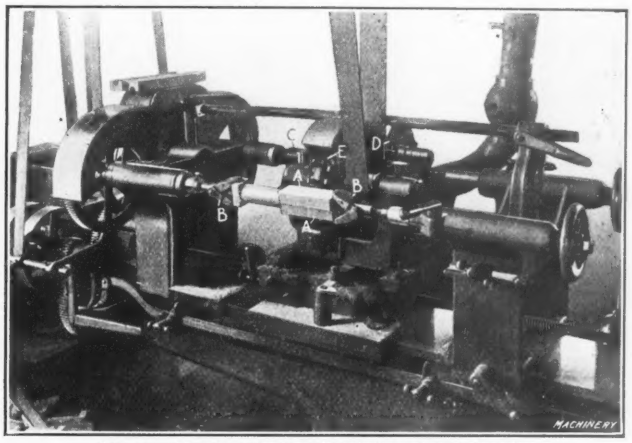


Fig. 16. Turning the Front and Rear Hand Guards

being accomplished on a cotton wheel, after which it is oiled with linseed oil and inspected.

Inletting and Turning the Front and Rear Hand Guards

Thus far, the description has been that common to the stocks for all types of rifles manufactured by the Ross Rifle Co. The

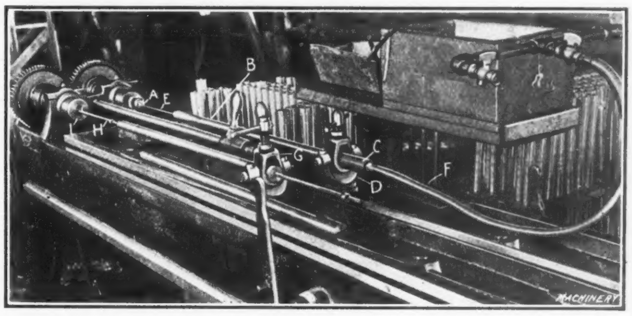


Fig. 18. Rough- and Finish-reaming Barrels in a Two-spindle Machine

front and rear hand guards are applied only to the military rifle, their use being principally to prevent the soldier from burning his hands when the barrel becomes heated after continual shooting. They also assist in protecting the rear sight and give a neat appearance to the gun as a whole.

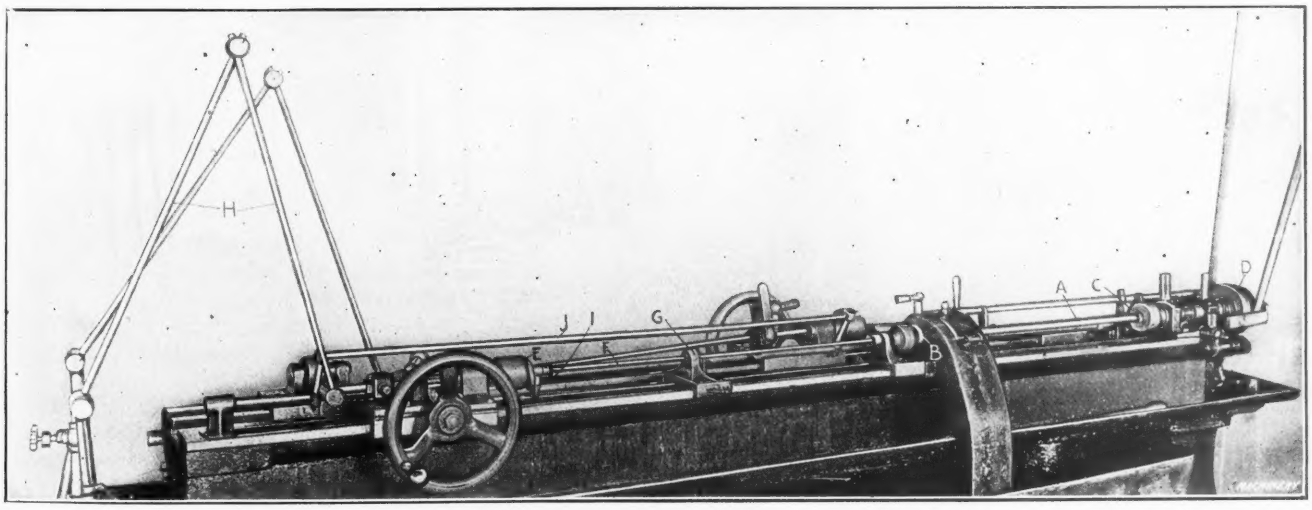


Fig. 19. Drilling Barrels in Pratt & Whitney Barrel Drilling Machine

The first operation on these bands is cutting them into blocks of the required length and thickness, which is done with an ordinary circular saw. After this they are taken to the inletting machine, Fig. 15, and clamped in a jig *A*, which is fastened to the table. Here the groove for the barrel is cut with scoop cutters held on the cutter heads *C* and *D*. These

heads are of the same design and work on the same principle as those shown in Fig. 11. The table is now moved along by means of the various handles placed at the side of the machine and brought under the cutter arbor *E*. This arbor is provided with cutters for cutting the grooves for the spring clips used in holding the bands on the barrel. This cutter arbor works on the same principle as the one shown at *Q* in Fig. 11.

The hand guards are turned in a Blanchard lathe as shown in Fig. 16, two pairs of bands being turned at one time. The two halves *A* are held by "alligator" jaws *B* on centers. The form or dummy *C* at the rear of the machine is made of the required taper, and, through a wheel *D*, guides the cutter head *E* to which the scoop cutters used in turning the bands are attached. One thing is very noticeable about all these wood-working machines, and that is the absence of cuttings. A large suction fan system employed throughout the works sucks in all the wood cuttings and carries them to the engine-room where they are used as fuel. Compressed-air blowers are also used for cleaning the chips off the machines.

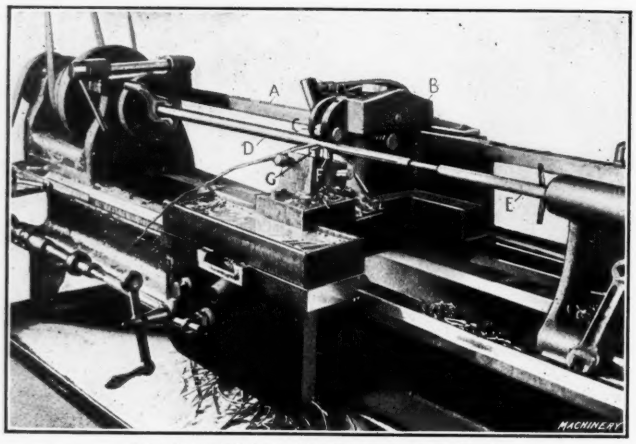


Fig. 20. Finish-turning Taper on the Barrel

Rough-turning Operations on the Barrel

The barrel for the Ross rifle is not drop-forged or rolled, as is the common practice, but is turned down from bar steel of special analysis. The first operation is cutting the long bar into suitable lengths for the barrel, in an ordinary circular cutting-off machine. The barrel is then centered in a centering machine, after which it is necked at the breech end with a wide forming tool, in a Jones & Lamson flat turret lathe.

The barrel is now ready for the rough-turning operation, which is accomplished in the Lodge & Shipley lathe shown in Fig. 17. The breech end of the barrel *A* is held in a chuck *B*, and the fore end is placed on the tailstock center. A bushing of the same diameter as the barrel—1⅜ inch—precedes the turning tools and is used to support the work while turning. The barrel is reduced from 1 3/8 to 15/16 inch diameter with two Novo 2 A high-speed steel turning tools, at a feed of 1/16 inch per revolution. The length turned is 26 inches, and with two lathes in operation one-hundred and twenty-five barrels are turned out in ten hours. After rough-turning, the barrel is turned taper in an ordinary lathe, which is equipped with a dovetailed guide, holding roller supports. The turning tool is operated by a square bar at the rear of the machine, which is set to the taper desired. The small end of the barrel is reduced to ¾ inch diameter in this operation.

Drilling and Reaming the Barrel

After rough-turning the taper, the barrel is taken to the Pratt & Whitney barrel drilling machine shown in Fig. 19, where two barrels are drilled at the same time. The barrel *A* is held in a bushing, located in the head *B* in which it revolves, and is driven by a corrugated bushing *C*. The bushing *C*, in turn, is driven by a friction pulley *D*, which also drives the lead-screw operating the head *E*, carrying the drill tube *F*. Should the drill stick and revolve, a dog *I*, attached to the head *E*, holding the drill, comes in contact with the bar *J* which, in turn, disconnects the feed-nut, thus stopping the feeding of the drill and at the same time shifting the belt from the tight to the loose pulley.

The location of the oil feeding tubes on these machines has been changed, the telescopic tube having been removed from the carriage. Formerly, if the drill stuck and the operator unlocked the feed-nut without shutting off the oil, the carriage would fly back at a terrific rate, on account of excessive pressure in the oil-feed tube. This caused considerable trouble, so the Ross Rifle Co. designed the scissor arrangement of tubes shown at *H*. This disposition of the tubes reduces the pressure on the carriage, so that the feed can be disconnected when the oil pressure is on without causing any serious results. The oil is forced into the barrel under a pressure of 1000 pounds per square inch.

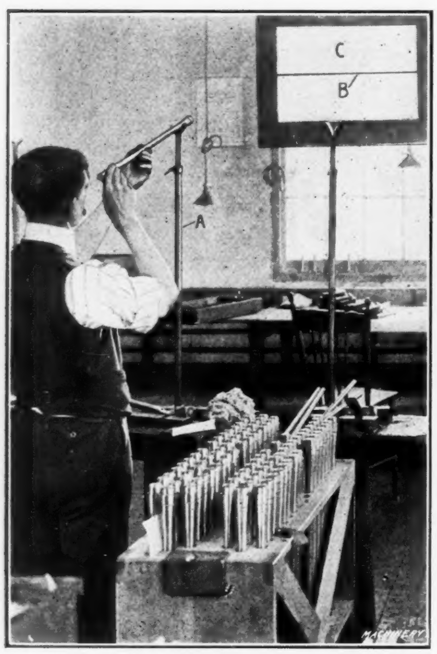


Fig. 21. Straightening the Barrels

Fig. 22. Gaging the Taper on the Barrel


Fig. 23. Producing the "Brown Finish" by Sweating

A C-drill, held in the forward end of tube *F*, is used. (A description of this drill is given in MACHINERY'S Reference Book, No. 25 on "Deep Hole Drilling.") This drill is provided with an oil and chip groove, the latter running back clear of the barrel and allowing the chips to work out freely. The barrel is rotated at 2200 R. P. M., while the drill is held stationary and is guided at the forward end by a bushing in the head *B* and also by a bushing held in the movable slide *G*. The drill makes a hole 0.290 inch in diameter, and as the finished size is 0.303 inch, this leaves sufficient material to be removed by the successive reaming operations.

The next operation is to rose-ream the hole to 0.300 inch in diameter. This is done in the two-spindle reaming machine shown in Fig. 18, which is used both for rose- and finish-

reaming. The spindle A is used for rose-reaming, and the barrel B is clamped in the bushing C, held in the slide D, the latter being operated from beneath the machine at the required feed per revolution. A rose reamer E, having four cutting teeth, straightens and gives a finished appearance to the hole in the barrel. Oil is pumped in through the tube F, so that the reamer is completely flooded at all times. The reamer in this machine is rotated, and the barrel travels over it.

Finish-turning the Barrel

The barrel has now been rough-turned taper and reamed and is ready for the finish taper turning. This is accomplished in the lathe shown in Fig. 20, which is provided with a special cross-slide, carrying a turning tool and roller supports. The cross-slide is operated by a square bar A, attached to brackets at the rear of the machine. This bar guides the head B carrying two roller supports C which support the barrel D while being turned. An ingenious floating center E is used on this lathe, so that the outside of the barrel will be perfectly concentric with the hole. A hardened and ground plug is provided with two diameters, one of which fits in the hole in the barrel, and the other of which is of the exact size and tapered to suit the external diameter of the barrel.

Before putting the barrel on the centers, this plug is inserted; then the carriage is brought over, so that the roller supports C rest on this hardened and ground plug. While in this position, the barrel is held against the supports by the spring plunger F. The floating center is then put in position, holding the barrel on the rear center. The headstock center is straight, ground perfectly true, and fits the reamed

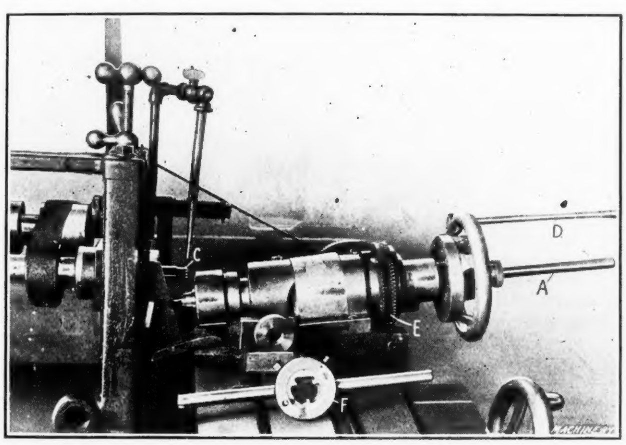


Fig. 24. Cutting the Thread on the Breech End of the Barrel

hole in the barrel. The turning is accomplished by a turning tool G, made from round rod and ground with a top rake of about 20 degrees, and soap and water are used as a cutting lubricant. It is evident from the foregoing description that it is possible in this way to turn the external diameter of the barrel concentric with the hole, which would be more difficult to accomplish if the barrel were placed on the ordinary centers.

Straightening the Barrel

We now come to one of the most important operations on the barrel, the correct execution of which governs its accuracy. After taper turning, the barrel passes through what is called a "straightening" operation. This is essentially a hand operation and requires the attention of a specialist. Many attempts have been made to devise a machine for straightening rifle barrels, but as yet all have been failures. The method used in straightening the barrel is as follows:

The straightener holds the barrel in his two hands, and places it in a Y-shaped support A, as shown in Fig. 21. He now sights the bore of the barrel on the strip of wood B, which is placed across a ground glass C mounted in a frame held over the window. The strip of wood casts two shadows down the bore of the barrel, each edge of the strip casting one shadow. Now if the barrel is slowly revolved, these shadows move in and out, that is to say, they do not remain the same distance apart throughout their length. To determine the exact point where the barrel is bent, the operator rotates the barrel with his right hand watching carefully the movements of these two shadows. If the barrel is much bent at some points these shadows will wiggle in and out in a very interesting manner.

The operator becomes so proficient at his work, that he knows the exact point at which the barrel is bent, and the intensity of the blow necessary to straighten it. The shadows do not extend the full length of the barrel, but gradually diffuse and become obscure after they pass three-quarters of its length, so that it is necessary to reverse the barrel end for end to complete the straightening operation. However, as these shadows are clearly perceptible for more than one-half the length of the barrel, it can be straightened its entire length by reversing. When the barrel is in a rough condition it is

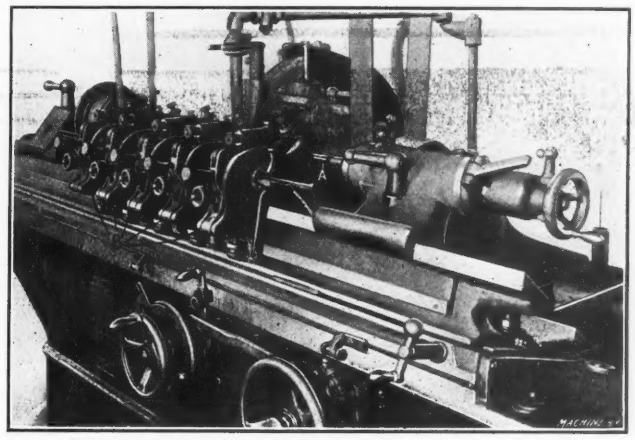


Fig. 25. Finish-grinding Taper on Barrels in a B. & S. Plain Grinding Machine

straightened with a steel hammer, but after it has been ground a copper hammer is used.

After the first straightening operation, the barrel is again taken to the lathe shown in Fig. 20 where it is again turned taper; then it is brought back to the straightener, given a few more blows and taken to another lathe where the neck—that part of the barrel close to the muzzle—is finished. The breech end of the barrel is then ground in a Brown & Sharpe plain grinding machine, after which it is reduced in diameter for the thread by means of which it is held to the receiver.

Threading the Breech End of the Barrel

Following the turning operation on the breech end, the barrel is taken to the threading machine shown in Fig. 24 where the thread is milled. The barrel A is held in a chuck in the revolving head. This head is inclined at an angle of 10 degrees with the horizontal plane, so that by using a cutter having one side flat and the other edge beveled at an angle of 35 degrees, a buttress form of thread can be cut.

In operation, the table is brought into position so that the center of the cutter C is on the center of the barrel; then the head is revolved by means of the handle D, to start the thread.

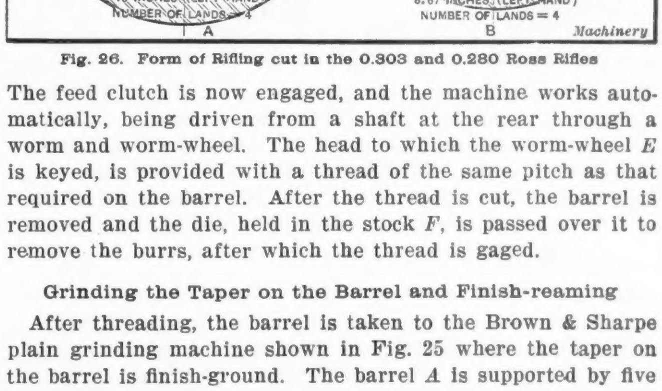


Fig. 26. Form of Rifling cut in the 0.303 and 0.280 Ross Rifles

The feed clutch is now engaged, and the machine works automatically, being driven from a shaft at the rear through a worm and worm-wheel. The head to which the worm-wheel E is keyed, is provided with a thread of the same pitch as that required on the barrel. After the thread is cut, the barrel is removed and the die, held in the stock F, is passed over it to remove the burrs, after which the thread is gaged.

Grinding the Taper on the Barrel and Finish-reaming

After threading, the barrel is taken to the Brown & Sharpe plain grinding machine shown in Fig. 25 where the taper on the barrel is finish-ground. The barrel A is supported by five

B. & S. universal steadyrests *B* which are spring-actuated and resist the thrust of the wheel. These steadyrests are provided with bronze shoes which fit the finished diameters of the work and are prevented from further pressure on the work (after it is ground to the required diameters) by check-nuts. The barrel is located from the bore, hardened and ground plugs being fitted in the breech and fore ends. The centers, however, in this case do not "float," but remain stationary as is common in this type of grinding machine. Before the barrel is again straightened, the taper is gaged in a special gage provided for the purpose, as shown in Fig. 22. The taper on the barrel is gaged at three different points—for the front and rear sight base and in the center. This gage consists essentially of a rod *A* on which six blocks *B* are held. The spaces between these blocks are "limit" allowances, a snap gage having a slot equal to the required diameter working in between them.

The barrel now passes through another straightening operation—a copper hammer being used. It is then taken to the reaming machine shown in Fig. 18 where it is held in the head *G*. A rod *H*, to which is attached a square reamer, is held in the chuck *I*. Oil is placed on the reamer, and a rosewood shim is held in one of the grooves by a washer. This shim backs up the reamer and keeps the cutting edge at all times in contact with the work. Many types of reamers have been used for this finish-reaming operation, but the old square reamer used holds first place as giving the best results. It requires, however, the attention of an experienced operator. This reamer finishes the bore to 0.303 inch diameter. A plug gage 0.302 inch diameter by 6 inches long must drop through of its own weight after reaming, which, of course, necessitates a very accurate finish.

Cutting the Rifling Grooves

Aside from making the hole in the barrel perfectly straight, possibly no operation on a rifle requires such careful attention as does the production of the helical grooves termed "rifling." The accuracy as well as the efficiency of the rifle depends to a large extent upon the proper execution of this operation. Rifling may be defined as "a series of helical grooves cut in the bore of the barrel which cause the projectile while passing from the breech to the muzzle to rotate." The rotation thus imparted to the bullet continues during flight giving gyroscopic stability and overcoming the tendency of the bullet to erratic flight, caused by the irregularity of its form or density. The shape of the grooves cut in the Ross rifle is shown in Fig. 26, where *A* is a cross-section of the 0.303 barrel and *B* the 0.280 barrel. The four projections or lands *a* form corresponding grooves in the periphery of the bullet, and in this way rotate it and keep it point-on.

Rifling was first applied to weapons for sporting purposes and did not come into prominence for military guns much before the middle of the nineteenth century. However, it is stated that it played an important part in the American War of Independence, in which the weapon used for sporting purposes only became of necessity a military arm. Napoleon tried this type of rifle out, but abandoned it again in favor of the smooth bore in 1793. The first military rifle on record provided with rifling grooves was the Baker rifle. The barrel was 2 feet, 6 inches in length, had seven grooves with a spiral of one turn in 10 feet, and was bored 0.615 inch in diameter. The type of bullet used in these first rifles was spherical in shape, and the velocity, as well as the accuracy, was not very great. A later rifle invented by Mr. Forsyth had a bore 0.704 inch in diameter and was provided with two grooves of semicircular shape with a twist of one turn in 30 inches—the length of the barrel. The ball or missile had a belt cast completely around it which fitted in the rifling grooves.

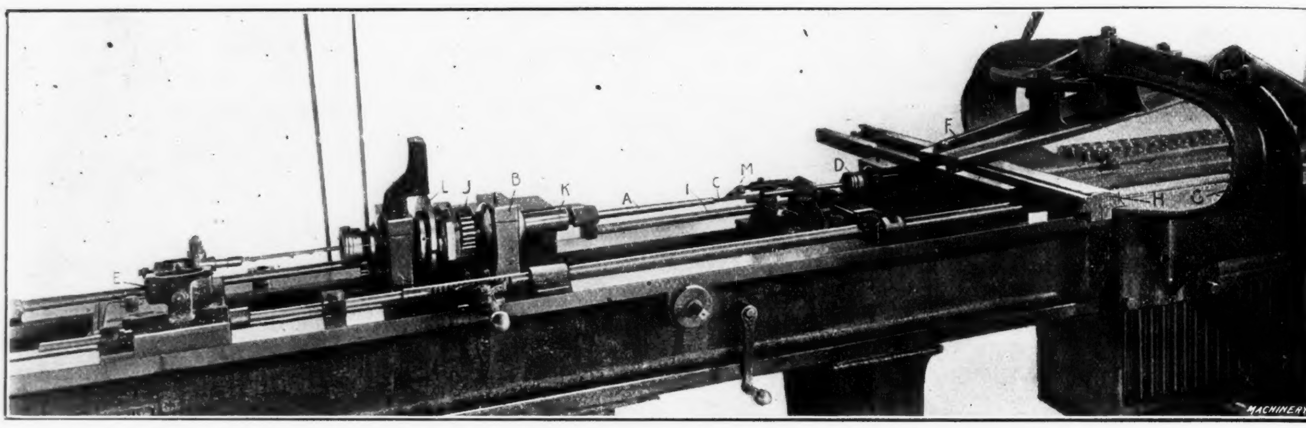


Fig. 27. Cutting the Rifling Grooves in a Pratt & Whitney Rifling Machine

The machine used for producing the rifling grooves, shown in Fig. 27, is made by the Pratt & Whitney Co. The barrel *A* is held in a chuck in the indexing head *B*, by means of a nut which fits on the threaded end of the breech, and the front end of the barrel is held by a split bushing in the spindle *K*. The rifling tool or "head," as it is called, is grasped in a chuck *D* which is located in a spindle provided with a spur gear. The helical groove is produced by a cutter of the correct shape, as shown at *A* in Fig. 28; the cutting face is shown at *a*.

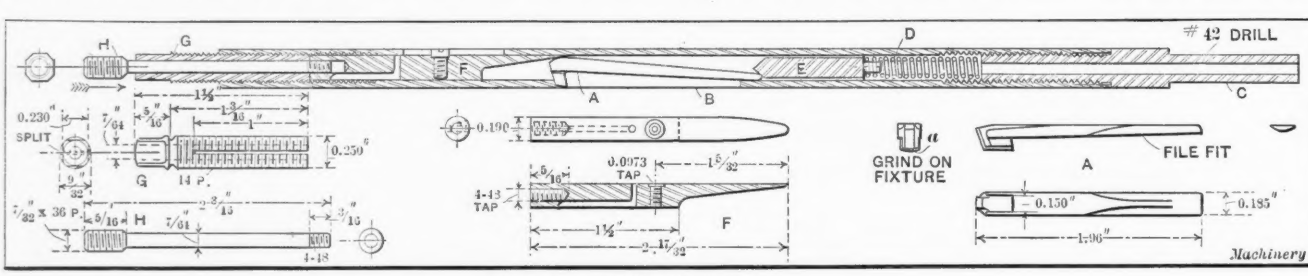


Fig. 28. The Rifling Head, Cutter, etc.

Before proceeding with the description of this machine, it may be well to describe the construction of the rifling head proper, Fig. 28. It consists mainly of a tool-steel tube *B* tapped in both ends. In one end is fitted an arbor or plug *C* on which a long tube is located, the latter being held in the chuck *D*, Fig. 27. Bearing against this arbor is a spiral spring *D*, operating a cone-pointed plunger *E* which bears against the rifling tool *A*, keeping it in contact with the adjustable wedge *F*. The other end of the tube is tapped out to receive the feeding-screw *G* which butts against the adjustable wedge *F*. The rear end of wedge *F* is tapped out to fit stop-screw *H* which is so set that the cutter can only be fed out the required amount. Stop-screw *H*, shown in its "relieved" position in the illustration, hits against a stop in the feeding-head *E*, Fig. 27, on the forward stroke, which forces it in the direction indicated, and as it is attached to the wedge *F* it forces the latter forward, thus sending out the cutter *A*. The cutting is only done on the back stroke, giving a draw-cut, so the cutter has

to be relieved, or, in other words, forced back out of action when returning; this is accomplished by finger *M* (see Fig. 27).

The Ross rifle is provided with four rifling grooves, as shown in Fig. 26, so that for every fourth revolution of the barrel, the feeding-screw *G* must be operated. This is accomplished by the feeding head *E*, Fig. 27, which is provided with a square hole in the end of the spindle fitting the squared end on the screw *G*. The turning of the screw *G* (in a right-hand direction) increases the distance between the stop-screw *H* and the feeding-screw, so that when the former hits the feeding-head *E*, the cutter *A* is sent out further, thus taking another cut. A chip averaging from 0.0005 to 0.001 inch thick is taken at each stroke, and is automatically removed from the muzzle of the barrel by a finger.

Returning to the rifling machine shown in Fig. 27, the pitch or twist of the rifling is accomplished by an arm *F* fastened to the O-shaped bracket *G* on which it is free to swivel when the nuts are loosened. This arm *F* is provided with a boss which is cut to fit a segment marked off for the different twists per revolution. A square groove is cut in the lower end of the arm in which a roller operates, the roller being attached to a slide *H*, which is provided with a rack on its under side; this rack meshes with a spur gear held on the spindle carrying the rifling head *C*.

The indexing of the barrel for the cutting of the four rifling grooves is accomplished by a rod *I*, attached to a flat plate in which is cut a cam groove. A roller runs in this groove, and is held on a rack meshing with gear *J*. Gear *J* is keyed to the spindle *K*, and as the former rotates it carries a ratchet pawl which meshes with a ratchet plate keyed to the spindle. A locking disk *L*, provided with four notches, is attached to this ratchet plate, and a spring plunger securely locks the disk when it has been indexed. The spring plunger is lifted by a cam on the ratchet plate coming in contact with a pin driven into the spring plunger, which lifts it up and allows the locking disk *L* to be rotated.

The feeding of the screw *G*, Fig. 28, is accomplished in the following manner. A one-lobed cam keyed to the spindle *K*, Fig. 27, comes in contact with a lever beneath it every fourth revolution. This lever, in turn, is in contact with a cam attached to a rod, the latter operating a ratchet which revolves the feeding disk, and turns the feed-screw *G*, when it is located in the square hole in the end of the spindle. The cut starts at the breech end of the barrel, and as the cutter reaches the muzzle a finger *M* hits the former, forcing it out of action and at the same time acting on wedge *F*, which carries with it the stop-screw *H*. This brings stop-screw *H* back into position ready for the next cut.

The breech end of the barrel is now chambered to receive the cartridges, and the muzzle end is chamfered inside and out to prevent it from burring. After this, the gage line is marked on it, so that it will breech up properly with the receiver. The cut for the extractor, and the entrance cut for the cartridge, are then made in a plain milling machine.

Producing the "Brown" Finish

The next operation is what is called the "browning" operation, this operation getting its name from the oxidized coating formed on the barrel during the sweating process. The barrels are placed in a rack—fifty at a time—and are dipped in soda and boiled; they are then rinsed in boiling water which must be absolutely clean. After this, they are coated with a solution of sulphuric acid and nitrate of alcohol. The rack holding fifty barrels is then placed in the sweating cupboards, shown in Fig. 23, which are provided with steam pipes. Here they are left for 3 or 4 hours, and when they come out they are covered with rust. They are then boiled, which increases the rust coating. The rust is removed with a cotton carding brush, leaving a dark surface on the barrel. This series of operations is repeated four or five times according to the depth of color required. Four times is usually sufficient, but the state of the atmosphere controls to a large extent the formation of the rust; on some days it requires five or more operations to get the same results. After the barrel is browned, it is inspected, which completes the manufacturing operations on the barrel. A final test for accuracy, however, is given when the sights are set by the government inspector. This will be described in the December number.

PHYSICAL HEALTH AND DRAFTING*

By L. R. W. A.

The draftsman's vocation demands good sight, apt conception, interpreting intelligence, and a steady hand, coupled with a degree of health which will permit of indoor confinement without serious consequence. Health is largely Nature's gift, but although it may be excellent, it is easily ruined through a lack of appreciation of the simple laws that govern it. Dealing with the self-inflicted ill consequences which may ensue from following the drafting occupation, we find that the most important questions deal with the right posture and the proper care of the eyes. In both cases, the question is simply one of the application of the elementary principle of common sense to one's work.

Proper Posture

How frequently do we see the draftsman commence his day's work by tying a small apron about his waist to protect the clothing from being rubbed, or, if this precaution is not taken, how often do we notice the vest and trousers shining from contact with the drafting board? Why is this necessary? Does the draftsman's pursuit call for a use of the abdominal portion of the body to correctly fulfill the duties? One is inclined to believe differently, and attribute it to a somewhat lazy disposition which finds this way "the easiest." It is, however, also a senseless short cut to bodily harm, absolutely unnecessary. The drafting board was never designed for this purpose, else an "edge-cushion" would have long since been adopted. The same reason "being the easiest," is likewise responsible for the stooped carriage, so readily acquired and so much more difficult to rectify.

That the effects due to improper posture may be serious, is obvious. They need never be experienced, however, if the draftsman takes care to keep his body in a proper position when working. The board should suit the draftsman's height and should incline slightly toward him, being a few inches higher at the back than in the front. The draftsman should stand clear of it, and bend over the work in such a manner that the back is not formed into a hoop shape. Rest firmly on both feet, and not on one at a time. This posture when once acquired will be found as easy to occupy as the other injurious one. There is no question of the benefits to be derived from it.

When the drawing is larger than normal size, covering the entire board, the rules given may not apply directly. If the drafting board is accessible from all sides, however, there is no difficulty; and if it is not, instead of leaning against the front, assume a sitting position on the board or rest the knees on the stool. When once the idea of keeping the body clear of the board is kept in mind, it will not only become the natural and easiest way, but will have a noticeable effect on the person and apparel.

The stool should be of a height to suit that of the draftsman. It ought to be of the adjustable type. It should under no circumstances be too high. The rigid wooden stool often used is usually made for high bookkeeping desks, and, as a rule, is too high for the drafting board. If the stool is too high, the draftsman must sit at his work in a contracted position. A bookkeeping stool can be made to suit the purpose by sawing off the legs to the correct height. The draftsman should make it a point to sit erect, both on account of his health and for appearance—a curved back on a young man is not particularly to his credit. It should not be implied from the foregoing that a rigid posture, either in standing or sitting is intended, but one may be easily comfortable without leaning against other objects in either position. If it is necessary to lean against the board, let the elbows rest on it.

It is hardly within the province of this article to elaborate on the subject of exercise; nevertheless the draftsman should take proper exercise. Breathing exercises, walking, and exer-

* For additional articles dealing with this and kindred subjects, see MACHINERY, May, 1911, "Physical Injury from Drafting"; April, 1911, "Ventilation of Drafting Rooms"; February, 1911, "Notes on Drafting-room Lighting"; and January, 1911, "Physical Injury from Drafting."

cises that tend to prevent him from becoming stoop shouldered are especially recommended.

Light in the Drafting-room

There are few branches of industry which require more excessive demands on the eye than drafting work. It is required that the draftsman do his work accurately, neatly, and often to a scale where the details become of minute dimensions. Hence the requirement for good vision is obvious, and the strain on the eyesight is considerable. In the following we shall deal with the two subjects: the care of the eyes, and the light in the drafting-room.

The first principle as regards the care of the eyes is to adopt the correct distance between the eye and the work, governed by normal sight. It is a common occurrence to witness that out of a score of draftsmen at least one-half work with their eyes very close to the drawing. To work with only a few inches between the board and the eye exposes the latter to an abuse that no eye can for any length of time be subjected to without permanent injury. In some cases this injurious condition may be due to insufficient light, but in the majority of instances it is due to a habit cultivated from the beginning of the draftsman's career. Remaining uncorrected, it invariably calls for the use of powerful eye-glasses in the end. If so close a position of the eye to the work is caused by natural near-sightedness, the draftsman should wear proper glasses. If, however, when wearing glasses properly adjusted to the eye, it still becomes necessary to work with the eyes so close to the board, then it would be advisable for the man to leave an occupation so exacting to his eyes, and find some work in another branch of the business. An example of the effects of the habit mentioned may not be amiss. In the engineering department of a large plant a set of standards was worked up. They were executed on tracing cloth, blueprinted, and bound in sets. The lettering work was distributed among the youngest men; the figures varied on the different sheets from 3/32 to 3/16 inch in height. One of the men who had been working at the board for about eighteen months, spent an equal period on this work. When starting on this work the distance between his eye and the board was about 9 inches; a short period later about 4 or 5 inches, and after a year's time the nose and board were almost in contact. This is because "he could make better figures that way." He then adopted glasses, but in a few months left to engage in another line of business. That the nature of the work subjected the eyes to excessive strain is certain, but if the man had adapted him-

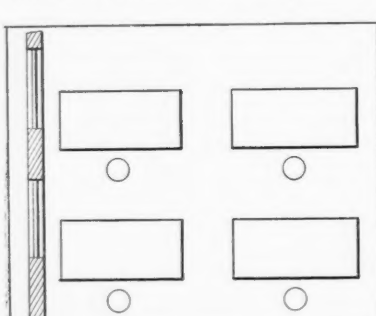


Fig. 1. Approved Arrangement of Drafting Boards

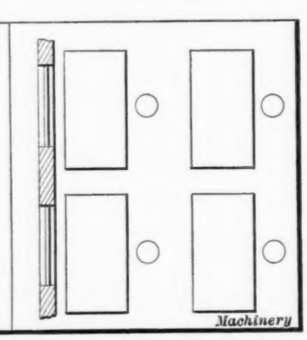


Fig. 2. Unsatisfactory Arrangement of Drafting Boards

self to it and used good judgment in the work, there would have been no need for this disastrous result. The writer has himself been through the same ordeal without ill effects. To give exact figures for the correct distance between the eye and the board which will fit all draftsmen, or even a majority, would be next to impossible, but as a general rule, with normal sight, from 9 to 12 inches is close enough for any work which the average draftsman is required to do.

Tracing from drawings and blueprints is a severe test on the eyes, and special care should be used, especially when doing this work for any length of time. Tracing from blueprints is especially liable to cause undue strain, and the draftsman should rest his eyes frequently. Such slight delay will be more than counteracted by his ability to work efficiently when resuming his task.

It is very important that sufficient natural light be provided in the drafting-room. The position of the board with relation to the windows should be as shown in Fig. 1. The board should not be in direct line with the window, but somewhat back of it. This position makes the light fall upon the board at a proper angle, and at the same time it does not allow the table nearest the window to entirely monopolize the supply. With the arrangement shown in Fig. 2 the table nearest to the window gets most of the light, and a great fault with this method is also that there is a glare which will affect the draftsman's eyes when he sits constantly facing the windows. The arrangement in Fig. 2, therefore, is not to be recommended.

It seems the custom when a man enters upon his duties in a drafting-room—provided he does not happen to be thoroughly competent or "high-priced"—to accord him the most isolated position available. This is particularly true if he is learning the business. The place he is given is usually unfit

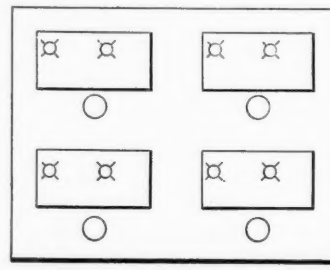


Fig. 3. Arrangement of 16-candle-power Suspended Lights

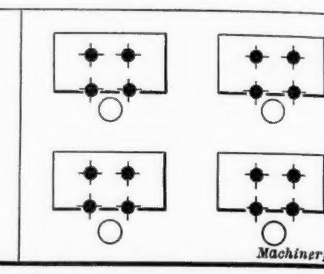


Fig. 4. Arrangement of "Inverted" Tungsten Lamps

for any kind of drafting or clerical work, and requires the need of artificial light throughout the day. It is a frequent occurrence to see such a man use another's board, if the latter is absent for a day or two, in order to obtain better light. This proves conclusively that at his own table the light is insufficient. The earning capacity of a boy or young man should not figure in a question of satisfactory working conditions in accordance with his duties. Whether the compensation be $10.00 or $30.00 a week, each man is entitled to equal consideration in regard to light. The younger man's sight is as important to him as is that of the higher salaried man.

The draftsman must endeavor to obtain as uniform a light as possible, and of ample volume. He should never work with the sun or with an unusual glare upon the board, even if he can "see better that way." Shadows are usually hard upon the vision, and incidentally hinder rapid progress, as they make a reversing of the tools and a constant shifting of position necessary. It should be a practice for the draftsman to rest his eyes at intervals. This does not infer "loafing," or staring out of the windows into the bright sunlight; a condition of absolute rest for a minute or two is what is required.

The most common system of artificial illumination is a drop light and reflector with 16- or 32-candle-power lamps. The writer's experience is that a 16-candle-power lamp hardly renders sufficient light for the size of the ordinary drafting board. A 32-candle-power lamp, again, offers a more concentrated and glaring light, causing reflection back from the tracing, which is not favorable to the vision. Two 16-candle-power lamps, therefore, have been found to give the greatest satisfaction, if arranged by two drop cords as indicated in Fig. 3. One of the lamps is placed at the extreme left, and the other a little to the right of the center. By using lamps so arranged, one of them can be turned out in cases when the shadows thrown by it are objectionable. The addition of a piece of transparent tracing paper stretched over the base of the reflector and pasted to its edges, thus hiding the lamp proper, will afford a soft diffused light. [A frosted globe would seem more advantageous.—Editor.] For tungsten lamps, properly arranged, a 40-watt lamp should be suitable.

In Fig. 5 is shown an example of an adjustable lamp fixture which eliminates the necessity of using two lights, and is very satisfactory. It consists of an arm and reflector mounted upon a rod at the back of the drawing board, and supported a few inches above the board by means of small brackets. A T-shaped carriage with universal joint for the lamp arm at *A* permits the rod to be held in any position. Floor sockets are used at the back of the board with a sufficient length of

cord to permit the lamp to be moved along the rod. The strictly portable desk lamp with stand is not advantageous for the drafting board on account of the space it requires, the difficulty of moving it about and of using it in connection with an inclined drafting board.

When individual lamps are used, as previously referred to, the proper height of the lamp above the work is ordinarily a condition which the draftsman himself controls. The lamp should not be held too high causing a glare; neither should it be placed too low, as it then will produce an undue amount of reflection which is harmful to the eyes. Too brilliant an illumination is just as dangerous as insufficient light. Artificial light resorted to when daylight is available is very bad for the eyes.

Ceiling lighting in the drafting-room has not given general satisfaction, owing to the casting of shadows and the glare of the light; it has but few advocates, and there are fewer installations of this kind. Recent tests of this method of illumination conducted by Mr. C. E. Clewell* indicate favorable results with lamps arranged as shown in Fig. 4. Here sixteen 40-watt tungsten lamps in groups of four to each board are placed in a room 16 by 20 feet with a ceiling height of 11 feet 6 inches. The lamps are inverted so as to point upwards, and opaque reflectors are used for throwing the light towards the ceiling.

[One excellently lighted drafting-room, about 25 by 60 feet, which we have had the opportunity to see when lighted with artificial light, was provided with three Nernst lamps of high candle-power. The ceiling was painted pure white,

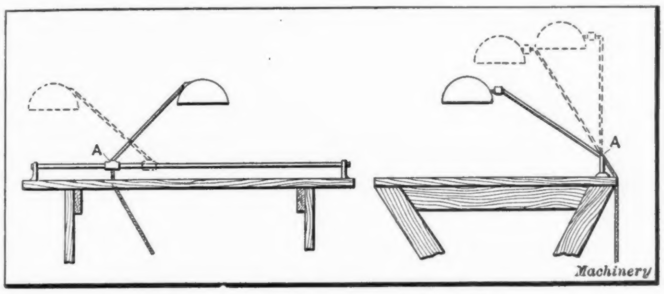


Fig. 5. Light held in Adjustable Bracket

and under each of the lamps a large reflector was provided throwing all the light towards the ceiling. A soft white well diffused light was then reflected from the ceiling onto the drawing boards. This method of lighting produced the best artificially lighted drafting-room that we have seen.—EDITOR.]

Headache is a common ailment among those who work with their brain and eyes. This is Nature's warning and should not be slighted if the ailment becomes frequent. Other signs of defective sight are as follows: 1. A mist appearing before an object viewed at close range. 2. A need for a light placed between the eyes and the object. 3. A necessity of holding small objects at a far range in order to see them distinctly, and partly closing the eyelid while viewing. 4. The apparent running together or blurring of lines or letters. 5. A state of continual fatigue of the eyes, or necessity for closing and rubbing the eyes frequently. 6. The appearance of spots floating before the eyes.

These are a few common ailments which especially apply to the draftsman and his work. If any of these defects become apparent, special care should be taken and proper glasses should be resorted to, if necessary.

Ventilation in the Drafting-room

Air is a chief sustainer of life and health. Pure air is indispensable to a healthy existence. The purest air, under natural conditions, contains in 10,000 parts about 4 parts carbon dioxide (CO_2), while an atmosphere vitiated through poor ventilation may be contaminated to the extent of 70 to 80 parts of this gas. It is estimated that under usual working conditions in offices, approximately 2000 cubic feet of air per hour is necessary for each person.

Considering this subject with strict reference to the draftsman and the drafting-room, we will eliminate, in general, any phase of technical discussion relating to ventilation. The idea is simply to impress the value of fresh air with regard to one's physical and mental working power, to decry against the absolute disregard of the requirements prevalent in countless instances, and to offer such suggestions as will prove effective with little or no expenditure.

Space wholly unsuited to the purpose is often made to serve for a drafting-room; the smaller the establishment, implying the employment of but one or two draftsmen, the less attention is given to the actual requirements that efficient work demands. Any old place, not in use, seems good enough, whether it ever sees the real light of day or is accorded any supply of fresh air. Again, among larger concerns this same indifference may be noted. The drafting department is regarded as a necessary evil, and afforded quarters hardly fit for even the crudest clerical work. In many cases this may be attributed to the fact that the man in charge has never served his time at the board, and consequently fails to appreciate the draftsman's labor.

In a small machine shop the writer has seen a lone draftsman work over a board placed in a foreman's partitioned office, and far removed from air and light; an electric fan was used to circulate the vitiated allowance of the former, while artificial means served for the latter. The foreman frequented the place no more than necessary, but the draftsman was expected to devote a ten-hour day to design and detail in this room. In a million-dollar incorporated light and power company with a practical operating man for superintendent, the drafting-room, employing three men, was placed in a corner of the transformer room, adjoining the switchboard compartment. The room was enclosed by board partitions, containing barely sufficient space for the three boards. The heat in the winter was excessive, and in the summer it averaged between 95 and 115 degrees. Two small windows, opening into a rear yard, were the sole means of ventilation, letting in air which instantly covered a tracing with a thick layer of dust. If for this reason only, the window had to necessarily be kept closed. The instances cited are not exceptional, and where one draftsman has not met these experiences, many have. It proves that the health of the men in this calling is many times neglected.

Many otherwise well equipped drafting-rooms in large plants and office buildings, lack proper ventilation facilities. The discomfort of a stuffy, ill-ventilated room is apparent. Not only does it affect personal health, but a contaminated atmosphere invariably tends to produce a mental condition which decreases the worker's efficiency. The breathing of impure air brings a sense of drowsiness and a lack of ambition, and in no other branch of endeavor does it show more clearly than in that of drafting. The value of pure, fresh air cannot be over-estimated, and no effort or expense should be spared to supply it during the working day. It must not be regarded in any aspect other than that of an absolute necessity, the expense for which is indirectly returnable to the employer in the form of more and better work.

In a room well ventilated by natural draft, that is windows, doors and transoms, a thorough system of airing, rigorously followed, will, perhaps, be all that is required. The office boy should report in the morning a full half-hour before the men, and during this period he should open every window and door. A similar airing should take place at the noon-hour. This, coupled with sensible admission of fresh air through the day, will provide a reasonably pure atmosphere. This is applicable to any season of the year. Fresh air warmed, in winter, is entirely dissimilar to heated foul, stale air. The use of a system as suggested will eliminate the haphazard fashion of opening the windows when one happens to think of it, an entire morning passing with possibly a score of men in the room, and a lone window or two providing the entire air supply. Where smoking among the men is permitted, there is even a greater need for a constant air circulation, and a small exhaust fan, properly installed, will be found to render adequate service. Windows fitted with a fine mesh screen are especially advantageous in warm weather, when the greatest volume of fresh air is required. The windows are opened both from top and bottom. The screens will not only assist in excluding dirt and insects, to a fair degree,

* See MACHINERY, engineering edition, February, 1911: "Notes on Drafting-room Lighting."

but will protect drawings and papers used for reference and not fastened to the board from the danger of being blown out-of-doors by a sudden gust of wind. Provision should be made, by means of simple and inexpensive ventilators, to permit fresh air to enter the room during inclement weather. Much harm is done by allowing days to go by with no change of atmosphere. Where a mechanical system of ventilation is installed there may be no necessity for the suggestions offered, but such installations, particularly for a drafting-room, are in the minority.

All work of a confining nature is injurious to one's health, and none more so than drafting. A careless mode of viewing the simple demands of health in early life may easily lead to serious consequences in later years. The secret of longevity is founded upon the adaptation of oneself to the conditions of employment and sensible living. The draftsman is called upon to work with hands and brain and is entitled to a full allotment, while on duty, of fresh air, good light, and congenial surroundings; it is only through such conditions that he is enabled to creditably fill his duties; and of him, personally, is demanded the observance of the established rules of life and health.

* * *

REMARKS BY THE ONLOOKER

Prejudice is said to be due to lack of education and this, perhaps, is true, yet how many of MACHINERY's readers, supposedly fairly well educated, would, without prejudice, consider the purchase of a lathe made in New Orleans? I am sure I would hardly feel inclined to listen to a salesman talk about it. Many of MACHINERY's readers can well remember when most of the fine mechanical appliances were made in the East; a rough count of the ads in the October issue shows one and one-half times as many mechanical ads of firms in the West as in the East. This is a natural condition, and it seems to me that the trend will continue, until after awhile, perhaps, one may be willing to buy a lathe made in New Orleans.

The rate charges for job works compiled by MACHINERY are interesting, yet at the figures given I cannot see in them, with a nine-hour day, even a moderate profit. Take an average rate of 65 cents per hour; the wages will be 30 cents leaving 35 cents for overhead expense and profit. Now I do not believe that with the shorter day this constant factor—overhead expense—is ever less, in a machine shop, than 110 per cent, and it is probably nearer 125 per cent of the labor cost, but at 110 per cent the possible profit is but 20 cents per day. Of course lower-cost labor is worked in, and file charges, emery cloth, etc., are all added, but still the return is not adequate even if it is considered true that you won't get poor taking profits however small. The question of overhead charges is one which almost always creates trouble and often the differences in rates are the result of it not having been made up on the same basis.

That jobbing shops are hard to run successfully is admitted, and I am also ready to admit that there has been a great advance in machine tool design, which is made perfectly plain by a glance through MACHINERY. Yet I am not ready to admit that a job is done much more rapidly today than it was twenty years ago. In manufacturing, it is true, the advance is almost beyond belief, but not many weeks ago I had to get a job reproduced which I had done twenty-two years ago, and the cost was a little more than what I then paid.

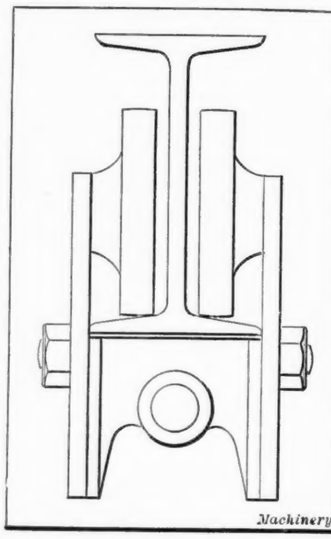
I do not think that the skill of the mechanic is any less. Looking at the produce of the extruded metal system, the cost of such forms as are shown on page 127, engineering edition, is but a fractional part of what it would be if machined, and some of the forms could not be commercially machined at all. There, then, is clearly shown a reduction in manufacturing cost and a wonderful advance in quality.

As an instance of advertising values, a client of mine has been paying, for years, $2.80 for a certain forging. I drew his attention to an advertisement and now he is paying 80 cents for the same thing—quite a nice saving to make by just using one's eyes.

The pencil sharpener illustrated brings to my mind the time when I was very proud to be able to buy a pewter-covered shaped affair that broke about 95 per cent of the points of the pencils I tried to sharpen. I wonder if they are still made? What a contrast with what is now obtainable!

The I-beam trolley illustrated is interesting. I suggest the modification shown, as giving a little more hoist room (that is always an advantage), and I get as stiff a trolley as does P. H.

I wonder if any other MACHINERY readers had as hard a time as I did in understanding Mr. F. B. Hay's file? Somehow the word "wall" seemed out of place and should have read "ceiling," but that would not have worked out with the elevation; after I understood the idea I liked it. I wish Mr. Hays would give the details of how the boards were put in. If I used the system, I would put a padlock on it, as somewhere in a shop a set of working and assembled drawings should be locked in, nailed down and soldered fast, so that under no circumstances could they be taken away necessitating a general hunt for them by the foreman and all hands. The time lost in some shops hunting for blueprints is great.



Suggested Improvement for I-beam Trolley

The method explained of aligning drills when using a jig will accomplish the end, but I do not like the practice of lifting the bushing out of the hole after starting the drill; that is, if the jig is to be used much and first-class results are desired; I have found that the hole wears, not by removing the bushing but by the action of the chips. Just here, I want to have a word to say about the word usually spelled "bush." If you turn to a dictionary you will see that "bush" means a "thicket" or "shrub." I have often been asked how the name came to be applied as it is in mechanics. The matter is made clear at once if the original spelling of the word is looked up; it will be seen that this is "bouche" which is the French word for mouth. A hole lined with steel is, then, "mouthed"—to translate it exactly. Here I think is an example of how unwise it is to change the original spelling of a word when it is taken from a live foreign language.

Of course the cow has always been a factor in mechanics, her hide giving us our belting and years ago our lubricating tallow, but I did not know that she had been helping the Standard Oil by giving her horns for oil-well packing, and if they are useful in such work they should be in many other places as well. I have many times made bearings out of rawhide and used water as a lubricant advantageously, and I have seen vertical shaft steps used in water turbines, made of rolled-up rawhide, which would outlast any other material tried.

The editorial remarks as to "It Can't be Done" bring to my mind something concerning the first breech loading guns. They were tested by the United States government just after the Civil War by officers who reported that they stood prescribed test, were reliable, and much more rapid in fire than the muzzle loader, but the Board could not recommend them for the troop, as to have a package with the powder, ball and cap all in one was too dangerous to be considered!

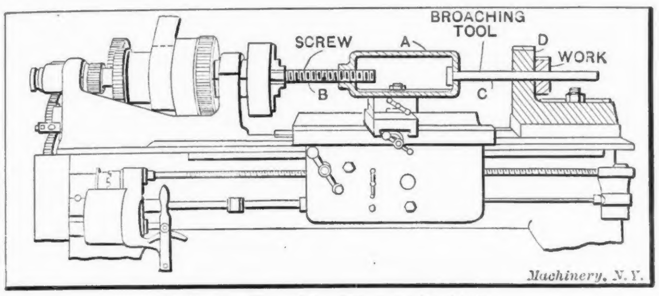
The idea that man cannot fly has been rooted in our minds. We use the expression "You can't do it any more than you can fly," and it is one that is looked upon as a classic. Yet, I believe that fifty years from today the sight of a horse will awaken more interest than a flying machine does now. The impossibility of riding a single wheel was mathematically settled by a French Society, yet a man was produced who rode one about the very stage from which the assertion was uttered. It is well to take the old darkey's suggestion that "it ain't wise prophesying unless you know." W. D. F.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

BROACHING ATTACHMENT FOR THE LATHE

A broaching attachment which can be applied to the lathe at small cost is shown in the accompanying illustration. This consists mainly of a forging *A* fastened to the cross-slide, and tapped out on one end to receive the screw *B* held in the lathe chuck. The other end is bored out to receive the broaching tool *C*, which is provided with a head, as shown, to prevent it from pulling out of the forging. The work is placed against the rear face of a rigid angle-plate *D* which is clamped to the



Device for Broaching Work in the Lathe

lathe bed, the tailstock casting having been removed. The angle-plate *D* and forging *A* are slotted through on one side, so that the broaching tool can be located in the work, and the broaching tool and work placed on the fixture.

In operation, when the work is located on the angle-plate, the nut in the apron is disconnected from the feed-screw, so that when the lathe chuck is revolved, the screw held in it will draw the carriage in the direction of the head, thus drawing the broaching tool through the work. The screw *B* should be provided with a head on the end held in the chuck so that it cannot be pulled out, and should be about 1 inch in diameter with a ⅛-inch square thread cut on it. For general work a screw 12 inches long will be sufficient. This device provides for a draw cut, which has been found the best for broaching work. D. FOSTER HALL

Springfield, Mass.

FORGING AND PLANISHING COPPER BLADES

A simple and effective means of rapidly cutting off, heading and planishing the copper blades shown in Fig. 1 is described in the following: The material upon which these operations are performed is ⅛-inch hard-rolled copper bars, 1 1/16 inch wide; the shape of these bars is best illustrated by the plain portion of Fig. 1, which shows the original stock. In order to satisfactorily upset the end to more than twice the thickness of the stock, and at the same time to produce work that is free from "cold shuts," with any degree of accuracy, careful heating of the upset part of the bar was required in order to avoid scaling. For this purpose the heating was done in a special gas burning furnace that confined the heat to a limited area, leaving all but the very end cool. In addition to making these special provisions for heating, a good deal of experimenting was performed to determine the best punch and die for the purpose. These experiments involved a series of trials with steel, various kinds being used with more or less success. The steel finally adopted was of a low carbon nickel variety which showed the best degree of resistance to fatigue, not being easily cracked or broken. The dies were used soft, no heat treatment whatever being given; in this way they stood up better and lasted longer. Following a run from eight to ten thousand pieces, the dies began to crack, but this was overcome in the same way as that adopted for drop forging dies, that is, by staking them, thereby closing up the cracks. The process, however, could not be repeated, owing to the accuracy of the work and the neat appearance demanded.

The machine used to perform the operations was a 1½-inch Acme forging machine, which cuts off the work with the toggle action cross-slide movement, at the same time carrying it forward and gripping it in the die preparatory to forging the head, the rear end abutting against the faceplate, thereby preventing the blade from slipping. In the illustrations, Fig. 1 shows the finished work after the forged end has been milled to size, Fig. 2, the die, and Fig. 3, the punch. The die consists of two blocks—a stationary and a movable one. The movable one is guided in its cross motion by the four guide pins shown, two of which are attached to the top of the movable block, and two to the bottom of the stationary block. The hot end of the bar being introduced into the stock-hole of the faceplate is shoved forward to the stock stop, the movable die in the meanwhile being in its extreme left position. The stock-hole in the faceplate is located about ¼ inch to the left of the die center-line. The movable die now moving over, shears the stock to the required length and holds it securely in the formed groove between the movable and stationary blocks. The shear has elongated bolt holes which compensate for grinding the cutting face.

The punch shown in Fig. 3 now comes forward, entering the die and forcing the metal to the required shape. Upon

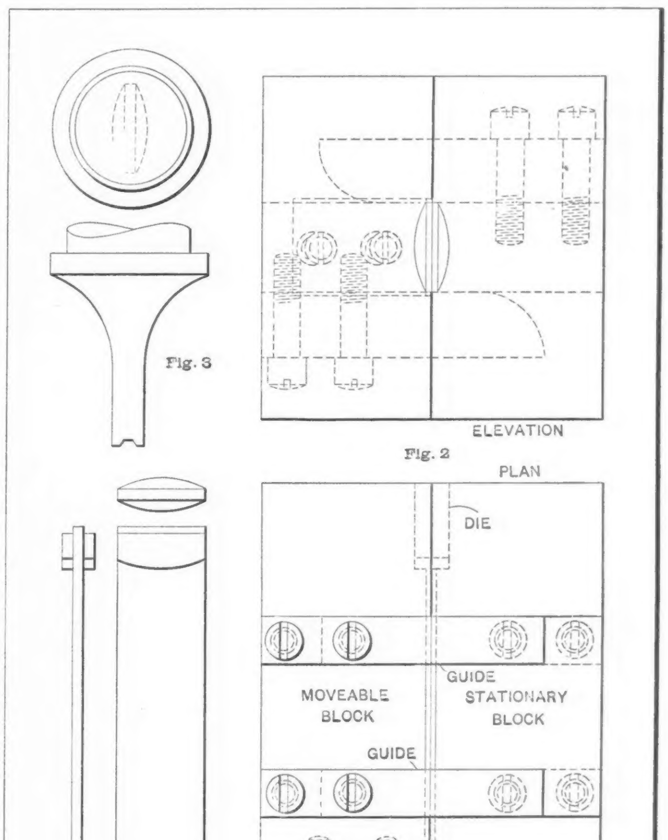


Fig. 1. Finished View of Blades made from Copper Strips. Fig. 2. Forging Dies employed on the Job. Fig. 3. Punch for Upsetting Ends of Blades

the completion of this operation the movable block moves back and drops the finished piece into a chute below. As the furnace heats the ends as fast as they can be handled, continuous operation is possible. The construction of the punch itself might be noted particularly. The slot across its face, which is shown in Fig. 3, guides the end and prevents it from springing to one side. This tends to form more perfect heads, particularly in the corners of the impression. With

a flat-faced punch, the tendency was to fold the metal, owing to the deflection of the hot end, just as the upsetting began.

The copper blades are next dipped, in order to cleanse and remove the discoloration incident to the heating of the copper. On the completion of this, the work is next passed through the operation of planishing under a 600-pound drop hammer. This is done in dies almost identical with those used in the finishing operations of drop forged dies, the result being that the work is straightened, stiffened and sized as to thickness, at the same time receiving a brilliant finish. These dies are made of carbon steel and are as hard as possible on the face, the working part being very smoothly finished in order to transfer a high polish. It is remarkable what a bright surface is given to these copper bars when struck a blow of sufficient force to decrease the thickness of the metal from 0.002 to 0.003 inch, provided, of course, that the dies doing the work are highly polished. Although the blades are finally buffed, this planishing action under the drop hammer materially decreases the cost of production.

Pittsfield, Mass. C. H. Rowe

STOCKING OUT A STEEL GEAR ON THE PLANER

We were at one time repairing our largest planer, and among the repairs necessary was the replacing of the large rack gear. This gear was made from a steel casting weighing about 500 pounds when turned, and had forty teeth 1½ inch pitch. From the appearance of the casting it was evident that there were a few hard spots, and to avoid the risk of spoiling an expensive gear-cutter we decided to rough out the gear on the planer. The way in which this roughing out was accomplished was as follows: The gear blank *A* was mounted on an arbor *B* which rested in two V-blocks *C*, and was clamped to them as shown in the accompanying illustration. On the outer end of the arbor was keyed an ordinary change gear *D* having 120 teeth, and the pawl *E* was arranged in a bracket to engage with the teeth in this gear.

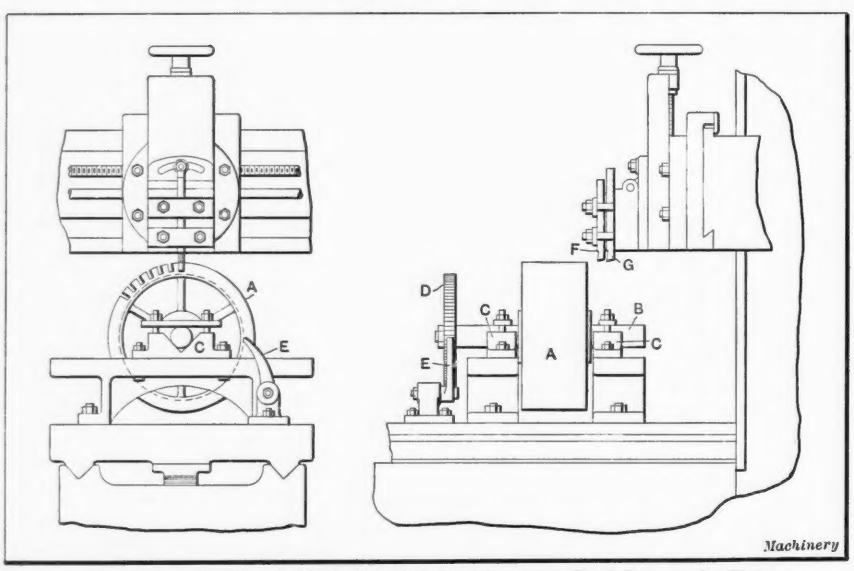
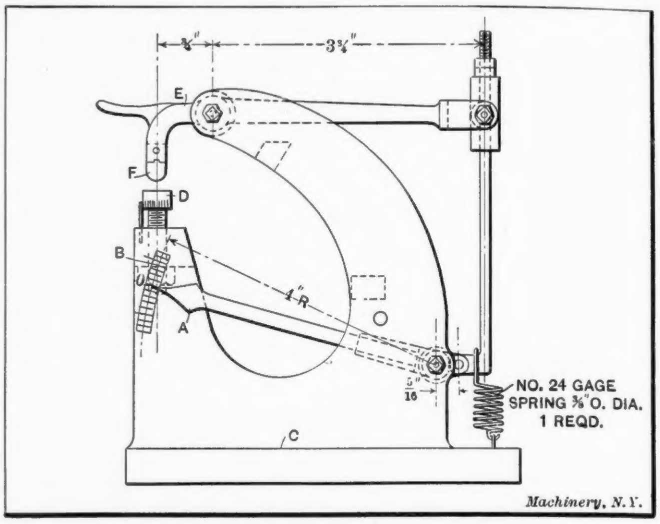


Illustration showing the Method used in Stocking out a Steel Gear on the Planer

When everything was set up, the machine was started and the automatic down-feed engaged. A dead stop was attached to the toolpost to give the exact depth—1.03 inch—but before this depth was reached the automatic feed was disengaged and the final feeding done by hand. The manner in which the roughing out was accomplished is of special interest as the method adopted was both efficient and rapid. Two tools *F* and *G* were clamped in the toolpost, and separated by a ¼-inch strip. The cutting part of the front tool was made 5/16 inch wide, while the rear tool was made 1/2 inch wide. The front tool was placed a few thousandths lower than the second tool. With this arrangement heavy cuts could be taken, as the chips from each tool were always narrower than the groove being cut, thus preventing the tool from binding or digging in. This method of holding the tools would be especially useful for splining in the planer, particularly in steel work. The time required to rough out one tooth using a feed of 0.015 inch was ten minutes including unclamping, clamping and indexing—it being necessary to unclamp and index, of course, for each tooth. G. Ear

MICA MEASURING GAGE

The accompanying illustration shows a micrometer gage for measuring the thickness of mica segments, which are used for insulation between the bars of motor commutators. However, its use is not necessarily limited to this class of work, as it could be applied to measuring sheet steel, etc.



A Simple Gage for Measuring Mica, Sheet Steel, etc.

Formerly this gage was so made that for a difference in thickness of 0.001 inch in the mica segment, a movement of only 1/64 inch was given to the pointer *A* on the scale *B*. As this movement was not easily detected, and as girls were employed in measuring these mica segments, it was found that this gage was not sufficiently "sensitive." The gage was reconstructed using the same casting *C*, with different multiplying levers, so proportioned that a difference in thickness of 0.001 inch gave a movement to the pointer *A* of approximately 1/16 inch.

In operation, the mica is placed on the anvil *D*, which is furnished with forty threads per inch and is graduated with twenty-five divisions so that it can be readily adjusted to suit the thickness of the pieces being measured. The anvil is adjusted to standard thickness gages, so that when the lever *E* is depressed and the measuring point *F* touches the mica, there will be no movement of the pointer *A*, that is, the pointer will be at zero when the mica is of the exact thickness required.

The gage was assembled before the graduations on scale *B* were laid off, they being so spaced that each division moved over by pointer *A* represents a movement of 0.001 inch of the measuring point *F*. At zero on the scale the divisions are 1/16 inch apart, but on account of the short length of pointer *A* the distance between the divisions will vary. To set the caliper when graduating the scale, "feelers" or gage strips were used, so that it was merely necessary to insert the proper strip between the anvil and measuring point *F*, and mark the corresponding graduation opposite the pointer *A*.

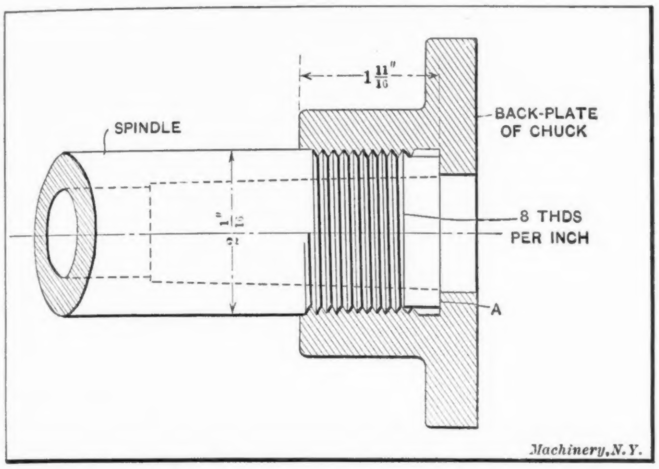
Akron, Ohio. J. S. Wilson

A CRANKY LATHE SPINDLE

The accompanying illustration shows the construction of the nose end of a lathe spindle with the back-plate of a lathe chuck attached. As will be seen, this construction differs from the ordinary design in that the usual thrust collar or shoulder for the chuck is absent, the thrust being taken at the end of the spindle by the surface *A*. In use, the chuck acts in a peculiar manner; when least expected it will

unscrew slightly and wobble on the spindle. The chuck cannot be at fault, as it is one of the best makes on the market, so it would seem as if the spindle must be the offending member. In the illustration the chuck proper has been removed from the back-plate for simplicity.

One explanation of this tendency of the chuck to wobble is that the thrust is taken too near the axis of the spindle,



Nose End of Lathe Spindle with Back-plate of Lathe Chuck Attached

and a cut taken at the outer end of a job in the chuck causes a rocking or see-saw motion of the chuck about its thrust-bearing, jarring the chuck loose. Probably some of the readers could suggest a more plausible reason.

Doubtless the difficulty might be remedied by forming a taper on the end of the lathe spindle which would fit in a corresponding taper in the back-plate similar to the lathe center taper. This expedient, however, would not answer nearly as well as a substantial thrust collar. In this particular, some of the best modern lathes are deficient, for instead of a collar of ample diameter, they merely have a low shoulder to take the thrust. This is a cheap construction, but it would seem to be poor policy to economize too much in so vital a part of the lathe as the spindle.

Atlanta, Ga. W. S. LEONARD

MACHINING GAS ENGINE PISTONS

In the following letter a description is given of the methods employed by the Potter & Johnston Machine Co., in the machining of gas-engine pistons on its automatic turret machines.

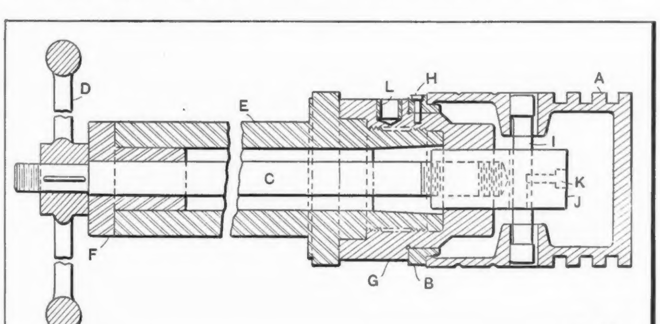


Fig. 1. Device used for Holding Pistons in Potter & Johnston Automatic Turret Machines while Grooving, Facing and Turning

The illustrations Figs. 1, 2 and 3 show a holding device, and also the fixtures used in turning the external diameter of the piston, and cutting the grooves for the rings. Before the piston is placed on the fixture shown in Fig. 1, it is bored out internally and the wrist-pin hole is drilled slightly smaller in diameter than the finished size.

The chucking arrangement shown in Fig. 1 is called a "hold-back" or "pull-back" device, the piston being held on it against the ring *B* by means of the pull-back rod *C* and the handwheel *D*. Rod *C* extends clear through the machine spindle *E* and is steadied on the rear end of the spindle by means of a bushing *F*. The fixture *G* is made to screw onto the nose of the machine spindle, while the ring *B* is held to it by means of the screws *H*. The piston *A* has its open end bored to fit snugly on the ring *B* and pull-back pin *I* passes through a link *J*, held centrally by means of the stop-pin *K*. The pull-back rod *C* is screwed into the link *J* and the handwheel *D* is keyed to the rod *C*, as shown. It is therefore clear that as the handwheel *D* is turned in a right-hand direction, it draws the piston tightly onto the bushing *B* by means of the pin *I* coming against the rear face of the wrist-pin hole. A hardened bushing *L* is driven into the fixture *G*, in which a pin fits to remove the fixture from the machine spindle.

In Fig. 2 is shown the cross-slide arrangement which is used for facing and grooving the piston while it is held on the fixture shown in Fig. 1. The grooves for the piston rings are cut by means of blades *B* and *C*; *B* designates roughing blades and *C*, the finishing blades. The blades *B* are carried in the auxiliary cross-slide block *D*, which is fastened to the standard cross-slide block by means of two collar-head screws *E* and tee-nuts, not shown. The blade *F* which rough-faces the end of the piston is held in a holder *G*, carried in the block *D*.

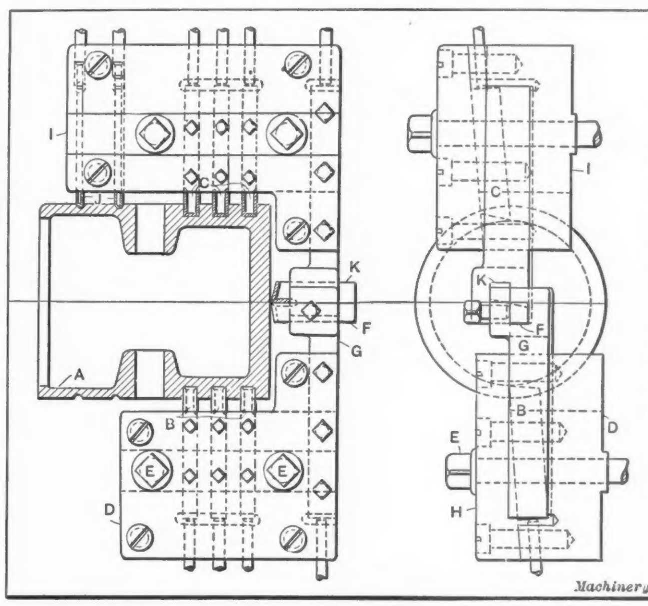


Fig. 2. Special Cross-slide Fixtures for Rough- and Finish-grooving and Facing Pistons

This holder *G* and blades *B* are held in place by set-screws which are located in the cap *H*, the latter being fastened to the block *D* by means of fillister-head screws. As will be seen in the end view, the blades *B* are set at an angle of about 5 degrees, while the holder *G* is set straight.

The rear block *I* is similar to block *D* with the exception that it carries two blades *J* for cutting oil grooves in the piston. Blades *C* are for finishing the grooves for the piston rings, and blade *K* is for finish-facing. All the blades in the

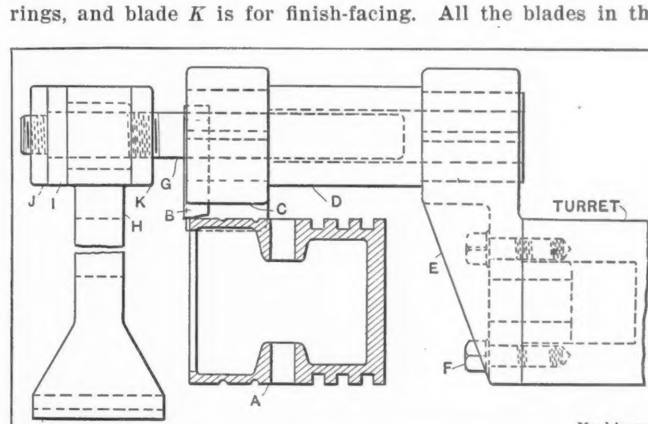


Fig. 3. Fixture used for Rough-turning the Piston

holders *D* and *I* are furnished with backing-up screws, to provide for adjustment, which are set at the same angle as the blades in the holder.

In turning the external diameter, the piston is held on the fixture shown in Fig. 1, where is is rough-turned by means of the cutter *B* located in the head *C*, Fig. 3. Head *C* is held tightly upon sleeve *D* which, in turn, is fastened to holder *E*, located on and clamped to the turret face by means of four

collar-head screws *F*. The holder *E* has a shank on it which fits into the hole in the turret. Sleeve *D* is bored out to fit a pilot pin *G*, which is held firmly in the bracket *H* by means of the eccentric bushing *I*, and the nuts *J* and *K*. The pilot bracket *H* is held firmly to the machine bed by means of straps.

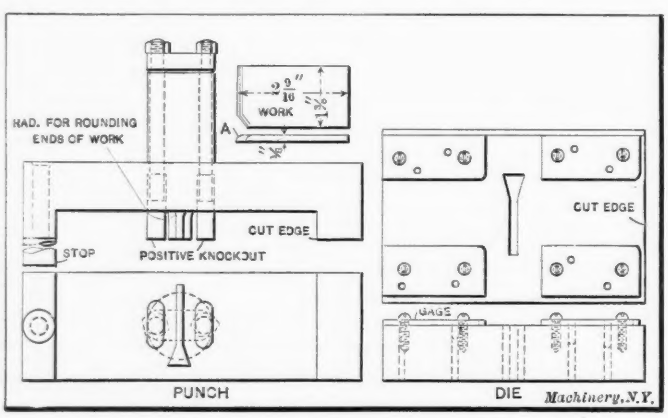
For finish turning, a tool is used which is called a "relieving stem," deriving its name from the working arrangement in which it is held. This stem, after taking the finishing cut relieves itself, and in returning across the face of the piston, does not mark its surface as a stationary tool would do. The piston is now finished, as far as the lathe work is concerned, the turning, facing, and grooving all being done without moving it from the machine, which effects a great saving of time in the manufacture of gas-engine pistons.

Westerly, R. I. HAROLD E. MURPHY

CUTTING-OFF AND COLD-SWAGING DIE

The accompanying illustration shows a punch and die for cutting off, parting in the center by the removal of a small section, and rounding the inner edges of hard copper flats such as the one shown at *A* in the engraving. These blades are made in large quantities in the various sizes and are used in pairs for knife-blade electrical switch clips.

Previous to the making of this tool, the blanks were first cut off in a press and the ends afterwards rounded by milling each piece with a formed cutter, in two operations. While a number of dies are used, some of them slightly different in design, the type here illustrated and described gives a good idea of the method now employed in the making of a



Cutting-off and Cold-swaging Die, and Copper Blade produced

pair of blades in the power-press by one operation and consequently at a higher rate of production.

The die of tool steel has a centrally located opening for the purpose of parting the two blanks and cutting the angular ends; gages as indicated are secured to the top surface as guides for the stock. The stop pin, driven in the punch, has its lower end made of sufficient length to project below the face of the die at all times; it is also in contact with the left-hand end, limiting the movement of the copper bar endwise and aligning the work for the punch to pass down over it so that it may be held firmly by the time the end pressure occurs due to the swaging action incident to rounding the corners.

The punch, in order to withstand the great strain to which it is subjected, is a one piece tool-steel forging, hardened and ground to dimensions and form. The fillet is carefully finished for the twofold purpose of strengthening the center cutting portion and rounding the ends of the work when the punch has entered the die to the requisite depth. Meanwhile the right-hand end cuts this blank from the bar. The ejectors, one for each blade, operate through the shank, being joined together by a strap across the top; their action is positive as they contact with a knockout bar extending horizontally through the press ram just before the latter reaches the full height on the up stroke.

Several dies of this type have been made, some of them cutting off and perfectly rounding blanks up to 3/16 inch thick and 2 inches wide. While the tools are giving satisfaction, standing up well, etc., it should be borne in mind that to utilize them to their highest available capacity, that is to obtain a perfect radius and flatten the blanks, a rigidly constructed press is essential, as the strain when the work is pressed between the two members is severe.

Pittsfield, Mass. C. H. ROWE

ACCURATELY THREADING PIECES IN ENGINE LATHE

The engraving Fig. 1 shows a lathe fixture made from a steel casting, for use in threading the malleable iron casting Fig. 2. These castings are usually machined in two-hundred lots in a turret lathe; but the importance of the thread

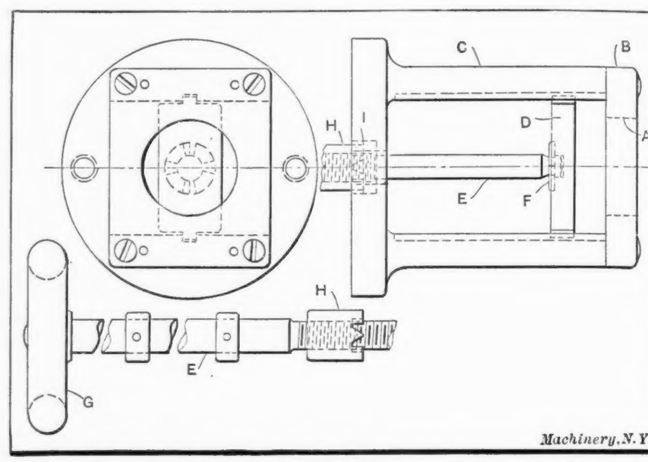


Fig. 1. Jig for Holding Pieces shown in Fig. 2, for Threading

requires that the threading be afterwards done in an engine lathe in the manner indicated in Fig. 3, two tools cutting both threads simultaneously. These tools are readily set to size, and are clamped to the slide-rest with two ordinary clamps, substituted for the toolpost. The internal thread tool is reversed in position in order to cut on the center with the face upside down. This method of threading was originated by the writer and introduced in the Boyer Mfg. Co.'s shop in St. Louis some ten years ago, where it has been in use ever since. The iron in these castings is very soft, with the result that the threaded sizes are retained by the tools all day, with an occasional oil-stoning on the face

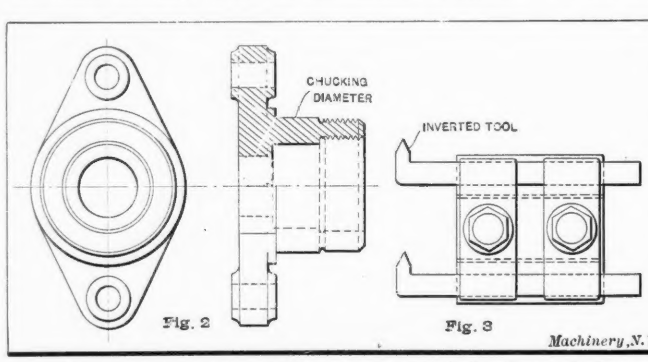


Fig. 2. Piece machined in Turret, to be threaded in Engine Lathe.
Fig. 3. Double Threading Tool used

of the tools. In the internal threading, a few thousandths inch is left for sizing with a special tap.

As the flange on the casting Fig. 2, is left in the rough, with the exception of the bosses which are faced, it is necessary to chuck the work by the finished diameter, back of the thread; for this purpose the fixture in Fig. 1 was designed. The hole *A* and back face in the casehardened machinery steel pieces *B* are ground and fastened to *C* by four fillister-head screws and are located by four dowel pins. *D* is also made of casehardened machinery steel, and has a bearing in the fixture on each tongue, this admitting of its sliding freely in the slot in *C*. The rod *E* is free to revolve in *D*, being held to it by a split washer *F* which is riveted in place with four pieces of 1/8-inch gun rod. *E* passes through the 1 1/2-inch hollow spindle of the lathe and is operated by hand-wheel *G*, the two collars on *E* maintaining it in central align-

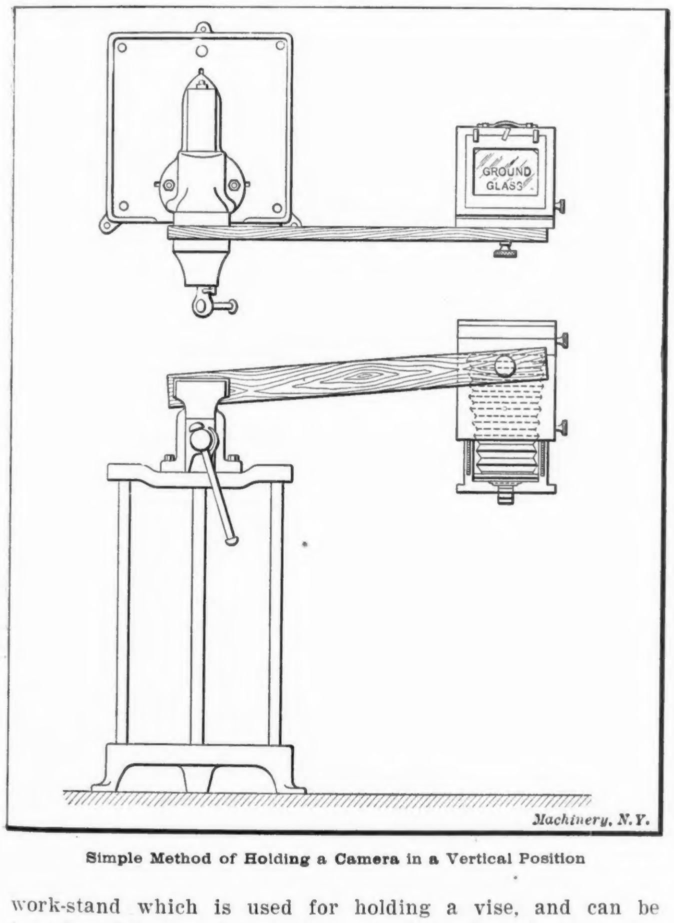
ment in the lathe spindle. The handwheel is removable, being held in place by a key and hexagon nut. *H* is a 60-degree clutch and nut combined, but only the teeth are casehardened. It is 7/8 inch diameter, 16 pitch, and threaded left-handed to correspond to *E; H* when in use, engages the clutch *I*, which is a drive fit in *C*. The clamping pressure on the work is not necessarily very great as the flange on the casting acts as a driver.

In service, *C* is clamped to the small lathe faceplate by two 5/8-inch cap-screws, a sheet of thin paper being inserted between. The hole in *B* is then set true with an indicator, *D* is slid to the back of the fixture, and the casting inserted in place, when *D* is brought forward to bear on the casting and is clamped by rod *E*, the thrust coming on the left-hand combined nut and clutch, which is prevented from turning by this clutch being engaged with clutch *I*. To remove the casting, handwheel *G* is given a turn which releases the pressure on *D*, the latter being free to slide as before.

Detroit, Mich. DAVID MELVILLE

BRACKET FOR HOLDING A CAMERA IN A VERTICAL POSITION

The accompanying illustration shows a simple arrangement for holding a camera in a vertical position, when photographing small articles placed on the floor, such as drills, arbors, etc., which cannot be readily fixed in a position suitable to the usual altitude of the camera. The vise fastened to the portable work-stand shown in the illustration serves as a holder for the bracket. The stand is an ordinary portable



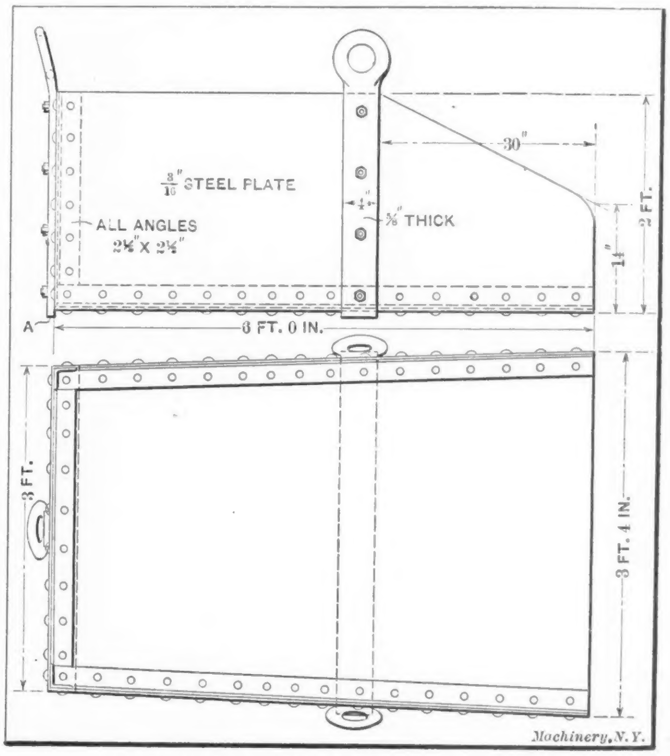
Simple Method of Holding a Camera in a Vertical Position

work-stand which is used for holding a vise, and can be transferred to the place desired. A piece of wood about 1 by 3/8 inch, and of a convenient length is gripped in the vise, and the camera is attached to this wooden strip by the same screw that is used in holding it to the board of the tripod. By this means the camera is held rigidly and away from any obstruction which would interfere with its field of view, as would be the case if it were held on the tripod. By having the camera held in this way it is possible to swivel it in any vertical plane simply by releasing the jaws of the vise and changing the position of the bracket.

Shipley, Yorkshire, England. L. B. OXLEY

BUCKET FOR TRANSFERRING METAL CHIPS

When handling metal chips in quantities, as, for instance, in transferring them from the shop floor to bins or loading on cars, the bucket shown in the accompanying illustration will be found to pay for itself in a very short time, especially in shops where a crane of any sort is installed. The ordinary chip-box used for transferring chips is usually closed on all four sides, while the bucket shown is open at one end, thus allowing the chips to be easily shoveled or pushed in. The handle at the rear end of the bucket projects past the bottom as shown at *A*. so that the front end is lowered when it rests



Bucket for Transferring Metal Chips in Quantities

on the floor, in the same manner as the house-wife's dust-pan. It will be noticed that the front end is wider than the rear, thus allowing easy admission of the chips. The bucket is suspended from the crane-hook by means of a circular ring connecting three chains, which have a hook on each of their ends, fitting in the three handles shown. When being lifted, all three handles are used, and when dumping, the hooks are removed from the side handles and the bucket is lifted by the rear handle and chain, only.

Schenectady, N. Y. J. H. CARVER

FINISHING CONCRETE FLOORS

There are concrete floors where the "sanding off" is very objectionable, and others where it might be necessary to mop them occasionally; yet, in their natural state it is impossible to mop them without having them absorb the water as rapidly as it is applied, and in the other the "sanding off" is disagreeable in many ways. Both objections can be overcome by painting with boiled linseed oil. After the cement has been "filled" with oil it takes on a smooth polish by constant use, and the floor can then be mopped and thus kept clear of dust.

To prepare, first, apply one or possibly two thin coats of the oil with a paint brush, working fast all the time for it cannot be "rubbed" out like paint on wood, and letting these dry a day; then another coat, waiting a couple of days until thoroughly dry, and so on until four or five coats have been applied or until the oil remains and dries on the surface. It is this top coat that gives it a linoleum finish and that causes the surface of the cement to take the polish instead of "sanding off."

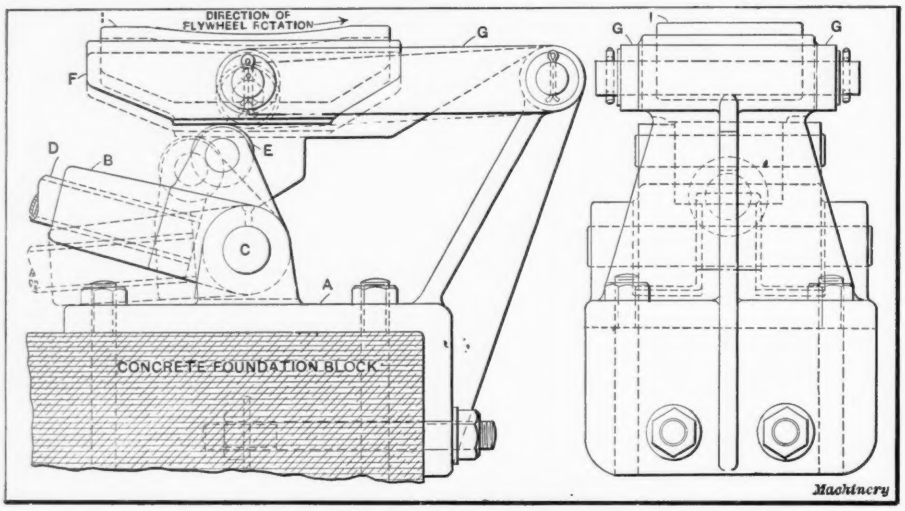
The floor in a large storage vault for tracings was finished in that way nine years ago; a year ago it received another top dressing of oil, and today it is smooth and glossy, will not

"sand off" and can be mopped whenever it is dusty without absorbing all the water.

Salem, Ohio. H. W. WEISGERBER

BRAKING DEVICE FOR POWER-PRESS FLYWHEEL

The large flywheel on punch presses, and in fact on other machinery as well, is often very difficult to stop quickly in case of an emergency, on account of the tremendous energy stored up in the rapidly revolving rim. The device shown in the accompanying illustration was designed to stop the flywheel quickly and easily. The customary method of stopping it, especially if the department head is not around, is by prying under the wheel with a piece of 2- by 4-inch timber, or oftentimes by the far more dangerous method of holding a piece of wood against the rim of the wheel by hand, and the writer has even seen flywheels stopped with the bare hands of the operator.



An Effective Device for Braking Large Flywheels

In the illustration, the braking device is shown assembled and mounted on a concrete foundation underneath the flywheel. Suitable fastening bolts are embedded in the foundation when the concrete is poured, and the bracket *A* is secured to the foundation by nuts. The bracket is of cast iron, properly ribbed, and is provided with two bosses between which the operating lever *B* rocks on the hinge pin *C*. A handle *D* of wrought-iron pipe is driven into this lever, and projects toward the front of the press, so that the operator may readily grasp it. The lever *B* carries a steel roller *E* at its upper end, and when this roller is forced under the brake tray casting *F*, it is capable of exerting a powerful thrust on the casting because of the toggle action of the roller and lever. The brake pan or tray *F* is hinged between two steel links *G*, which are fastened to the right-hand boss of the bracket *A* by a hinge pin, washers and cotter-pins. A maple block *I*, whose upper surface is curved to conform to the flywheel, is pressed into the tray *F* and acts as a brake shoe.

When the operating handle is allowed to fall, the tray comes to rest on the roller *E* on one side and on a boss projecting from the central rib of the bracket *A* on the other side, as shown by the dotted lines in the illustration. Where large punch presses or other machines embodying heavy and rapidly revolving flywheels are in operation, a device of this character will prove very effective and will meet with the approval not only of the men who operate the machines, but also of the factory inspectors who are always ready to endorse any device which will decrease the liability of accidents.

Detroit, Mich. ARON LAWRENCE

REMOVING A JAMMED FACE MILL

Recently in a large manufacturing concern a rather awkward milling job was put on a vertical spindle machine, an inserted-tooth cutter being used to perform the work. This was secured to the spindle in the usual manner, but as the cut was very heavy, when it was finally desired to remove it, it was found to be very tightly jammed and could not be budged.

The use of a long square bar between two teeth on top of the cutter was suggested, but beyond breaking off a few teeth, this method proved as futile as other attempts. It was finally decided to remove the spindle and turn the cutter away, it being deemed preferable to do this than to spoil the spindle.

The mechanic who was set to perform this task asked permission to try a little scheme which occurred to him. This consisted in taking a piece of waste, dipping the same in hot soda water and placing it around the hub of the cutter; then another piece of waste was placed under the ice water faucet and this pushed into the hollow spindle of the machine. After waiting a few minutes for the cutter to become warm and the spindle to become cool, a smart rap with a lead hammer on the cutter caused it to drop out.

This was a simple operation, merely putting into practice the property which metals have of expanding and contracting with heat and cold respectively. ESKIL RYLANDER

Providence, R. I.

DIAMETER OF SMALL ENDS OF TAPER PINS

The accompanying table gives the diameters of the small ends of taper pins, which vary in length from ¾ to 6 inches. This table will be found very useful for machinists and draftsmen, as from it the size of the drill can be obtained. This will save considerable time as it is not necessary to measure the pin to find the diameter of the drill to use. The sizes given apply to pins which are tapered ¼ inch per foot.

New Bedford, Mass. GEO. D. HAYDEN

DIAMETERS OF SMALL END OF TAPER PINS

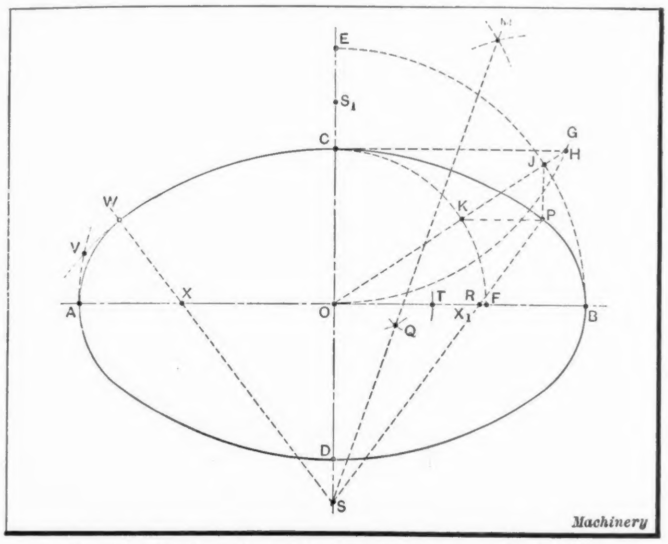
Taper, ¼-inch per foot

Size of Pin	0	1	2	3	4	5	6	7	8	9	10
Diam. Large End	0.156	0.172	0.193	0.219	0.250	0.289	0.341	0.409	0.432	0.591	0.706
Length in Inches	Diameter of Small End in Inches										
¾	0.140	0.156	0.177	0.203	0.235	0.273	0.325	0.393	0.476	0.575	0.690
1	0.135	0.151	0.172	0.198	0.230	0.268	0.320	0.388	0.471	0.570	0.685
1¼	0.130	0.146	0.167	0.192	0.224	0.263	0.315	0.382	0.466	0.565	0.680
1½	0.125	0.141	0.162	0.187	0.219	0.258	0.310	0.377	0.460	0.560	0 675
1¾	0.120	0.136	0.157	0.182	0.214	0.252	0.305	0.372	0.455	0.554	0 669
2	0.114	0.130	0.151	0.177	0.209	0.247	0.299	0.367	0.450	0.549	0.664
2¼	0.109	0.125	0.146	0.172	0.204	0.242	0.294	0.362	0.445	0.544	0.659
2½	0.104	0.120	0.141	0.166	0.198	0.237	0.289	0.356	0.440	0.539	0.654
2¾	0.099	0.115	0.136	0.161	0.193	0.232	0.284	0.351	0.434	0.534	0.649
3	0.094	0.110	0.131	0.156	0.188	0.227	0.279	0.346	0.429	0.528	0.643
3¼	......	......	......	0.151	0.182	0.221	0.273	0.340	0.424	0.523	0.638
3½	......	......	......	0.146	0.177	0.216	0.268	0.335	0.419	0.518	0.633
3¾	......	......	......	0.141	0.172	0.211	0.263	0.330	0.414	0.513	0.628
4	......	......	......	0.136	0.167	0.206	0.258	0.326	0.409	0.508	0.623
4¼	......	......	......	0.131	0.162	0.201	0.253	0.321	0.403	0.502	0.617
4½	......	......	......	0.125	0.156	0.195	0.247	0.315	0.398	0.497	0.612
4¾	......	......	......	......	0.151	0.190	0.242	0.310	0.393	0.492	0.607
5	......	......	......	......	0.146	0.185	0.237	0.305	0.389	0.487	0.602
5¼	......	......	......	......	......	......	......	0.300	0.383	0.482	0.597
5½	......	......	......	......	......	......	......	0.294	0.377	0.476	0.591
5¾	......	......	......	......	......	......	......	0.289	0.372	0.471	0.586
6	......	......	......	......	......	......	......	0.284	0.367	0.466	0.581

THE TWO-ARC ELLIPSE AGAIN

The ellipse construction given by the writer in the engineering edition of MACHINERY, March, 1911, has been criticised because the center of the end arc was not determined by a theoretically exact method. It would take a very accurate draftsman to detect the errors in that method, even for six-inch ellipses. The following *exact* construction may be used, however, for either large or small ellipses, of all proportions. For the sake of completeness the whole process will be given, even though it involves some repetition.

In the accompanying illustration, AB and CD are the axes of the ellipse. With OB and OC as radii draw the arcs BE and CF. With E as center and OE as radius draw arc OG. Draw CH parallel to OB, intersecting OG at H. Draw OH,



Method for Locating Centers for Drawing an Approximate Ellipse by Circular Arcs

cutting arcs CF and BE at K and J, respectively. Draw JP parallel to OC. Draw KP parallel to OB. With C and P as centers, and with a radius about equal to CP, draw short arcs intersecting at M and Q. Draw MQ intersecting CD at S. Then S is the center of the arc WCP which represents one arc of the ellipse. With a center at T and a radius AT equal to CS, draw the arc AV cutting arc WCP at V. With V as a center and the chordal distance AV as a radius draw a short arc cutting VCP at W. Draw WS cutting AOB at X. With X as a center and AX as radius draw the arc AW so as to form the end of the ellipse. The two remaining centers S_1 and X_1 may now be easily located and the ellipse completed.

It will be an easy matter for anyone to make a comparison between this and the previous method. Simply draw PS cutting OB at R. Point R is the approximate center which, on ellipses less than six inches long, is so close to the true center X_1, that the two can scarcely be distinguished.

Mr. J. J. Clark, in the engineering edition of MACHINERY, July, 1911, wonders why the writer did not give an exact method of finding the centers X and X_1 of the end arcs. The writer had for some time been seeking a simple method of finding a point P on the true ellipse such as would lie at the junction of two arcs which could be used to construct an approximate ellipse. The method described in the March issue was discovered, and it seemed to be an exact method because a magnifying glass, used in constructing ellipses as large as six inches long, failed to show an appreciable error. To make certain, however, the method was investigated mathematically, and it proved to be only a very close approximation.

In any construction, however exact it may be theoretically, there are so many small unavoidable inaccuracies in its practical use, that it did not seem worth while (in this case) to seek further for a way of more closely locating the junction points of the two arcs, or the centers of the small arcs. The final adjustment of centers would be made anyway, even with a theoretically exact method, so that when inked the arcs would join perfectly.

Mr. Clark offers two methods of locating the centers of the end arcs. The first is a good one, though not so simple and accurate as the one given above, but the second seems too complicated to be of practical value.

South Bethlehem, Pa. H. A. S. HOWARTH

TEMPLETS FOR ANGLES

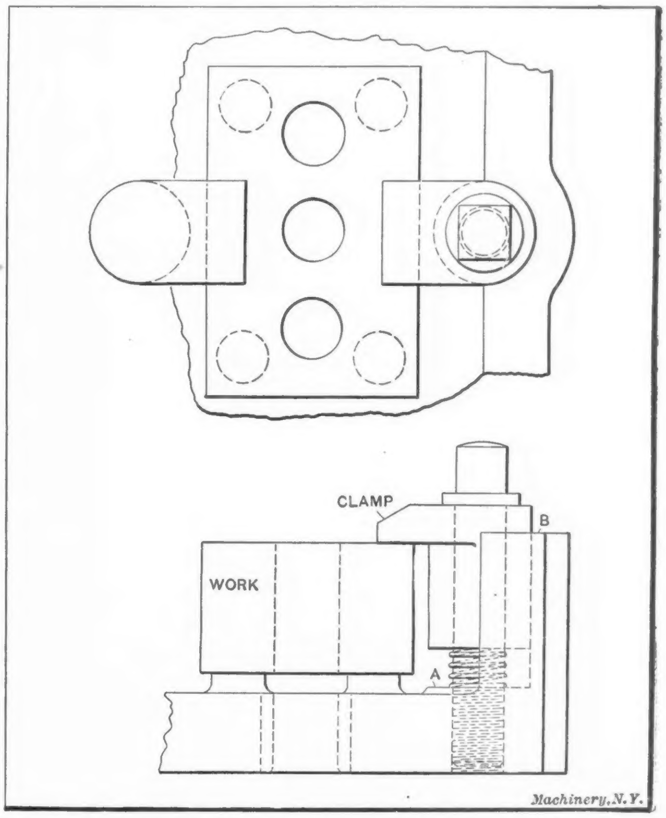
When it is necessary to lay out taper angles, such as those required in cored holes, draft for rough parts, standard Acme thread taper, pipe taper, etc., the writer finds it very convenient and at the same time accurate to secure thin pieces of wood about 6 inches long, scratching them with a scriber to the angle desired, then having the patternmaker plane to the lines. By marking the angle on the templets and then shellacking them over, handy and useful tools are made. A ¼-inch hole in one corner so that they may be hung up, makes them more convenient.

Many draftsmen use this scheme, and those who do not will find it very convenient if they will but give it a trial.

J. C.

A CLAMPING DEVICE

The accompanying illustration shows a simple but effective clamping device for jig or fixture work. The jig is not shown in full, the outline being sufficient to illustrate the application of the clamp. This device can, of course, be used for a number of cases other than that shown. The casting to which the clamp is applied should have a boss A cast on it as shown, and the surface of boss A should be in the same plane as the surface of boss B, so that the seat for the clamp can



An Efficient Clamping Device for Jig and Fixture Work

be counterbored. This is accomplished by drilling and reaming a hole, smaller than the tap drill size, entirely through the boss. This hole guides the teat of the counterbore, which is used for counterboring a seat for the clamp. The seat is one of the most important features of this device, because if the clamp is not properly backed up, its efficiency will be impaired. If the clamp screw alone were used for taking the back thrust, it would become bent and prevent the clamp from seating properly on the work.

With this device, no amount of pressure will bend the screw, and this is not true of any other clamp except the flat sliding strap, which also requires a seat or boss to rest upon. Of course many other satisfactory means of clamping could be used in the simple case shown, but this clearly illustrates the application of the device. R. G. B.

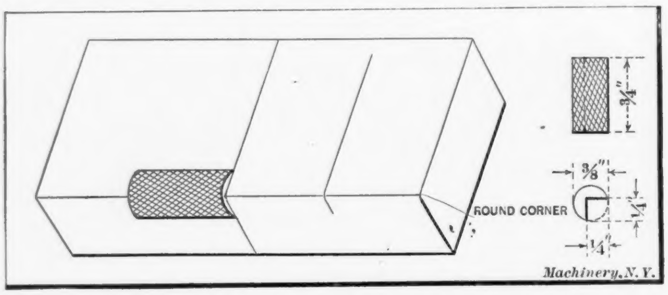
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this department. Write on one side of the paper only and draw sketches on separate sheets.

A SMALL SQUARE FOR TOOLMAKERS' USE

The accompanying illustration shows a small square which is called by shop men a "square square." This tool is made from 3/8-inch drill rod, and is milled out, as shown, and then hardened. A piece of 5/16-inch drill rod is next gripped in the chuck of the grinder, ground to run true, and the square clamped to it. When one end is ground square, the tool is reversed and the other end finished in the same manner.



This tool is used by toolmakers in laying out dies, jigs, etc., and is found especially useful when it is necessary to continue a line around a block having a round corner, as is shown in the illustration. The line is started with this tool, and then continued with an ordinary square.

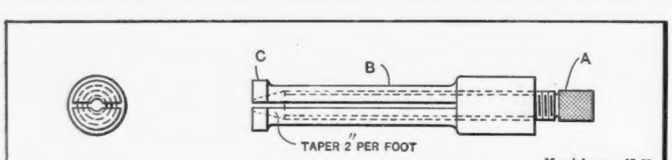
Detroit, Mich. C. L. VANERSTROM

A SCREW CUTTING KINK

When cutting a screw, instead of putting a stop on the lathe bed, a scale can be used to advantage. Having taken the first cut, stop the lathe and lay the scale on the bed with any convenient inch line, in line with the rear end of the saddle. Then lift the clutch, disengaging the nut from the lead-screw, and move the saddle back to the nearest inch mark from the end of the work. Drop the clutch and proceed as before. If the thread should be 11½ pitch, the distance to which the saddle is moved back should be an even number of inches. S. H. C.

AN ADJUSTABLE PLUG GAGE

The accompanying illustration shows an adjustable plug gage which can be used for gaging the sizes of holes, and is especially useful for obtaining the size when lapping ring gages. This gage may also be used for setting the grinder to cut parallel, when doing internal work. The gage is made



of tool steel, hardened, and is slotted, as shown. A cone-pointed screw A is provided for expanding it.

The method of using this gage is as follows: The gage is inserted in the work, and the screw A manipulated until the gage fits the hole. Then the gage is removed and the size determined by an ordinary outside micrometer. If the hole is a long one, the size is determined at the front and then at the rear, and the difference in diameter noted. The only thing to keep in mind in making a gage of this kind, is to have the neck B long, the gage end C short, and to close the prongs of the gage before hardening. C. T.

* * *

A great dam is being built in the Mississippi River, between Illinois and Iowa, at Dallas City, Ill., which will cost $27,-000,000 and develop about 200,000 horsepower. It is expected that the cheap power thus made available will develop a great manufacturing city.

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

LEAD OF SPIRAL OF TWIST DRILLS

C. G. B.—In MACHINERY, June, 1911, you gave data for fluting and relieving twist drills, but did not include the spiral or lead. What is the standard spiral for each size of twist drill up to 3 inches diameter?

A.—There is no accepted standard for the lead of spirals of twist drills, but a common rule is to make the lead seven times the diameter of the drill. Thus a ½-inch drill should have a lead of spiral of 3½ inches; a 1-inch drill, 7 inches; a 2-inch drill, 14 inches; and so on.

MACHINERY FOR MAKING STEEL WOOL

W. L. C.—A substitute for sand-paper that has come into common use is steel wool or shavings. Will you kindly inform me if you know of a concern that manufactures machinery for producing steel wool?

A.—We know of no maker of machinery for producing steel wool and would be glad to have the names of any makers. One process of making steel wool is essentially a lathe operation. Sheet-metal disks are mounted on a mandrel and fine shavings are turned off in the lathe. We are informed that another source of supply is the fine shavings produced by deep hole drills in drilling rifle barrels.

MOTTLED COLORING ON MACHINE STEEL

H. M.—How is a mottled effect obtained on articles of machine steel?

A.—The method given below is used by a prominent toolmaking concern. This method was described in the February, 1909, number of MACHINERY in an article entitled "The Manufacture of Taps," and is as follows: The object to be treated is first highly polished and then very carefully cleansed of all oil in a hot soda solution. It is then slowly heated to a temperature of from 150 to 200 degrees F., by placing it on the hot firebrick covering the top of an oil-burning furnace. When heated to the degree mentioned, the steel is put into a pot of heated cyanide of potassium and brought to a dark red heat. It is then dipped into clear water and vigorously moved about in this. Unless the work is moved about when cooling off in the water, the mottled effect desired will not be obtained.

WHY A BODY IN MOTION RESISTS DEFLECTION

L. M.—Why does a body in motion resist deflection from a straight-line path?

A.—A body in motion tends to move in a straight line because deflection from a straight-line path accelerates its velocity. Acceleration of velocity demands an increase of the kinetic energy, which can come only from an outside source. To illustrate, suppose that a pound weight is moving at the rate of 100 feet per second. Its kinetic energy, calculated by the formula:

$$E = \frac{Wv^2}{2g}, = \frac{1 \times 10{,}000}{64.4} = 155.3 \text{ foot-pounds.}$$

Now if the direction of motion is deflected, say, 45 degrees, by a force acting at a right angle, the velocity will be increased in the ratio of the hypotenuse of a right-angle triangle having equal sides, to a side, or as 1.4142 to 1. The original velocity of 100 feet per second having been accelerated to 141.42 feet per second the kinetic energy is doubled, the expression then being:

$$E = \frac{1 \times 20{,}000}{64.4} = 310.6 \text{ foot-pounds.}$$

Hence the external energy required to deflect the weight from its path at an angle of 45 degrees is 155.3 foot-pounds, the difference between its kinetic energy before deflection and the total energy after its acceleration.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

VAN NORMAN GRINDING MACHINES

The Waltham Watch Tool Co., Springfield, Mass., is manufacturing a design of internal grinding machine which contains a number of interesting features, especially in connection with the spindle construction and the table operating mechanism. The spindle of this grinder is designed to operate indefinitely at speeds high enough to give the small wheels, used for internal work, a peripheral velocity equal to the speed employed for external grinding. The driving power is also sufficient to maintain these speeds while operating at the maximum cutting capacity of the wheels. The automatic stroke or traverse of the table is obtained through a new cam-operated mechanism, by means of which any variation can be obtained, from full stroke down to the point where the table remains stationary, and these changes can be made while

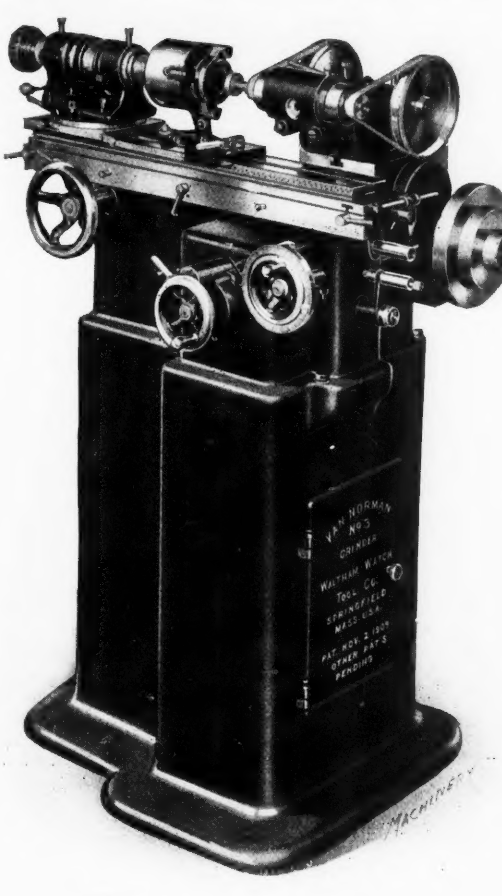


Fig. 1. No. 3 Van Norman Internal Grinder

the machine is in motion. The adjusting mechanism is so arranged that very minute changes in the stroke can be made.

The table reciprocating mechanism is shown by the sectional and plan views Fig. 5. The table derives its motion from a heart-shaped cam *C* mounted on a vertical shaft, which is driven, through a feed-changing mechanism, by the cone pulley shown to the right in Fig. 1. This cam *C* engages a roll attached to the lower side of an oscillating arm *A*, having on its upper side another roll *B*, which can be adjusted to or from the pivotal point *P* of the arm. This upper roll operates between the parallel faces of two members *D* which form a yoke, and the latter is attached to a rod *E* located beneath the table. On the under side of the table and extending throughout its entire length there is a dove-tailed slide-way in which is fitted a long sliding piece *F* attached to and moving with the reciprocating rod *E*. A lever binder *G*, located at about the center of the table, as shown in Fig. 1, serves to clamp the table to the slide piece *F*.

From the foregoing, it will be seen that when the cam rotates, a reciprocating movement is imparted to the table through the vibrating arm *A*, yoke *D* and the dove-tailed slide, provided, of course, part *F* is clamped to the table. The length of this movement or stroke is, of course, governed by the position of roll *B*, which can be moved along its slide by a screw connecting, through a universal joint and spur gears,

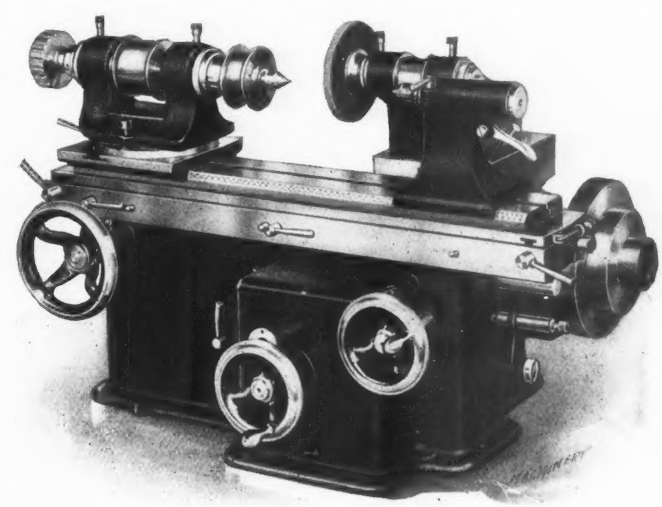


Fig. 2. No. 3 Van Norman External Grinder

with handwheel *H*, the spur gears being interposed to give a rapid adjustment. When roll *B* is moved inward until it coincides with pivot *P* of the oscillating arm, no movement will be imparted to the sliding rod *E* or table. When binder *G* is released, the table is free to be operated by the handwheel shown to the left of the machine in Fig. 1. An adjustable stop, carrying an adjustable screw which passes lengthwise

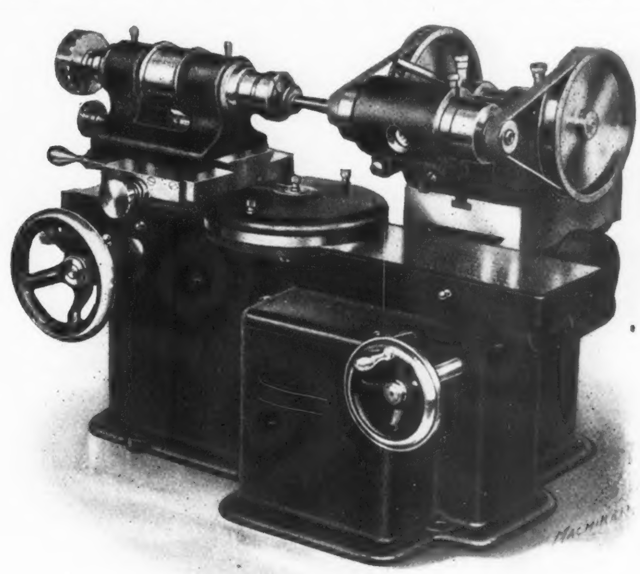


Fig. 3. Radial Ball Race Grinder

through the stop, is also fitted in the dove-tailed slide-way containing part *F*. This stop is at the left end of the table and it is used to bring the work in the proper endwise relation to the emery wheel when the table is set for grinding a certain part. The stop is shifted along the slide-way until the end of the adjusting screw is in contact with slide *F*. It is then securely clamped to the table by a binder at the front. This adjustable slide forms a positive stop for slide *F* so that the latter, after being shifted for testing the work, can be

brought back to the original setting. This is, of course, particularly desirable when grinding close to the bottom of a hole.

As previously mentioned, the table is provided with a feed-changing mechanism, as it is necessary with a cam-operated machine to have sufficient changes to maintain a practically uniform rate of travel, regardless of the length of the stroke. The No. 3 grinder illustrated has fifteen changes of feed, and the No. 4 size, twenty-one changes. A throw-out lever located at the front of the machine serves to instantly engage or disengage the feed from the cam mechanism. At the right end of the machine there is an indexing lever (see Fig. 1) that is used for locating the cam in the positions which it occupies at either end of the stroke. One complete turn of this lever gives a half revolution of the cam, and the index pin with which it is provided, should always be withdrawn before starting the feed. The cross-feed handwheel, which is shown at the right, has graduations indicating a movement of 0.0001 inch, and, if desired, this machine can be equipped with an automatic cross-feed.

The machine is adjusted for internal grinding by first disengaging the drive from the cam mechanism, by means of the throw-out lever previously mentioned. The table is then released from slide bar *F* and the adjustable stop is loosened. The cam is then revolved by the indexing lever and the table is adjusted to the required stroke. The cam with its reciprocating parts is next set to the extreme right-hand position, after which the table is moved to bring the emery wheel approximately in its bottom position in the hole to be ground. The table is then clamped to slide *F* and the adjustable stop is moved against the slide. After the machine is set in this way, the stroke can be tested by turning the indexing lever. In case it is desired to change the depth adjustment of the wheel slightly, this can be done in two ways: First, by turning the handwheel to vary the stroke, and second, by moving the adjusting screw in the stop beneath the table. In case the latter method is resorted to, slide *F* must be shifted to again bring it in contact with the stop.

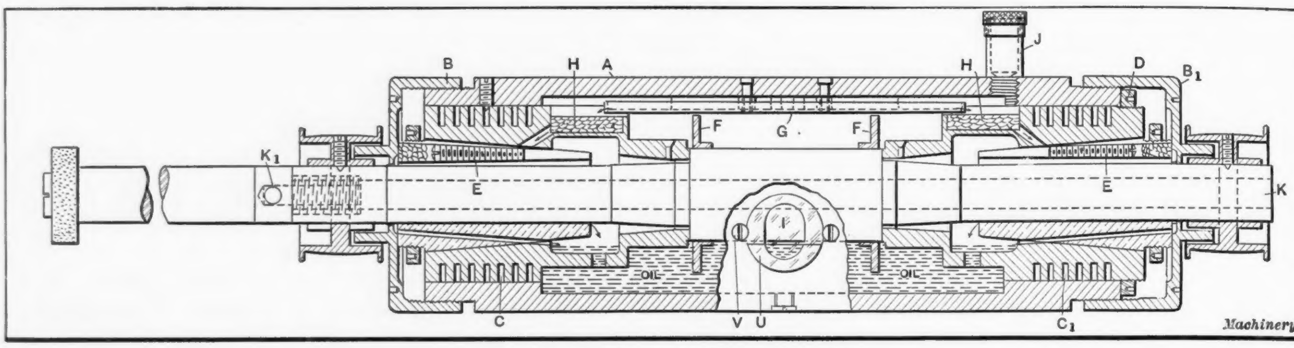


Fig. 4. Sectional View of High-speed Spindle

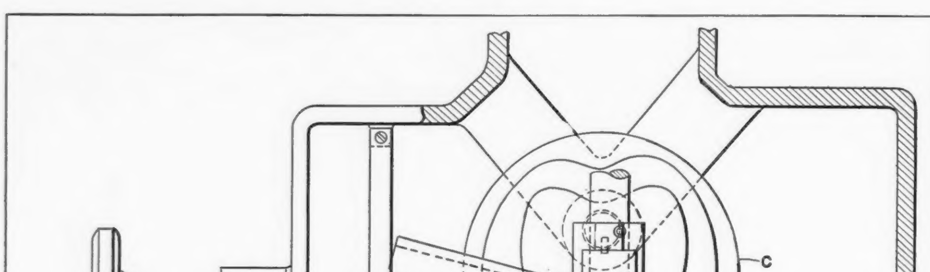


Fig. 5. Cross-section and Plan showing Table Reciprocating Mechanism

The quill and grinding spindle is clamped in a quill holder which can quickly be swung out of the way if desired. Means are provided also for bringing it back to the original position where it is rigidly secured. The grinding spindle is driven by two endless belts, ¾ inch wide, which operate on pulleys mounted close to each bearing as indicated in Fig. 1. The quill driving spindle at the rear is mounted on a "take-up" block for varying the tension of the belts, and the whole quill-driving mechanism is adjustably clamped to the top of the cross-feed slide.

The construction of the spindle and its bearings is shown in the sectional view Fig. 4. The outer casing *A* has inserted in its front end a fixed bearing holder *C*, which is secured by a set-screw, and in the opposite end of the casing there is an adjustable bearing holder C_1, having a threaded adjusting collar *D*. The inner ends of these bearing holders come in contact with shoulders formed by the enlarged central part of the spindle, and in this way the endwise adjustment is governed. Inserted in each bearing holder there are split taper bearings made of high-grade bronze. Threaded caps *B* and B_1 engage the ends of the bearings, thus holding them firmly in place. These caps have projecting annular flanges which enter recesses in the pulleys to prevent any emery dust or other

foreign matter from getting into the bearings. Endwise adjustment of the spindle is made by first removing the right-hand pulley and cap B_1. The nut D is then turned, thus shifting the position of bearing holder C_1. When making this adjustment, allowance should be made for a slight endwise pressure when the cap is replaced. To adjust a bearing radially, the pulley and cap are first removed at the end where play is to be taken up. The tapering screw E is then backed out slightly for closing the bearing, after the packing at its end is removed. When this change in the position of the screw is made, the pressure of the retaining cap, when replaced, will close the bearing on the spindle. In case the bearing is too tight, it is drawn back from the holder by means of a threaded draw-out collar, after which the taper screw is tightened slightly to force the bearing open. These collars are intended only for withdrawing the bearings and they should be screwed away from contact with the bearing holders before replacing the outer caps. The spindle should be adjusted so that it can be revolved freely with the fingers. A slight endwise movement is not objectionable except when grinding against shoulders.

On the central part of the spindle are two flanges F which enter an oil reservoir in the outer casing. The oil is lifted by these flanges, as they revolve, and is caught by a trough G, having a longitudinal partition through its center. The oil flows from this trough through the packing H, which not only filters it, but regulates the supply for the bearings. It then enters conduits which lead to the bearings and finally back to the reservoir, as indicated by the arrows. Annular recesses in the caps B and B_1, which connect with the return conduits, catch any oil which may work beyond the ends of the spindle bearings. Oil holes are also provided for keeping the shoulder bearings flooded. The reservoir is provided with a sight glass, which indicates the oil level. This reservoir is filled through cup J and it can be emptied by removing a screw at the bottom. This system automatically furnishes a constant flood of oil to the spindle bearings.

The spindle of the No. 3 grinder will maintain a speed varying from 40,000 to 50,000 revolutions per minute without excessive heating, and the No. 4 size can be operated at 30,000 revolutions per minute. Ordinarily, however, the spindles only make about 15,000 revolutions per minute, which gives a peripheral speed equal to that used in external grinding. In addition to this efficient system of lubrication, the spindle is air-cooled. A hole K is drilled through the spindle, as indicated by the dotted lines, and there is a cross-hole K_1 at the inner end. As the spindle rotates, the air is discharged from this cross-hole by centrifugal force, thus causing a continuous flow of air through the spindle, which helps to keep the temperature normal.

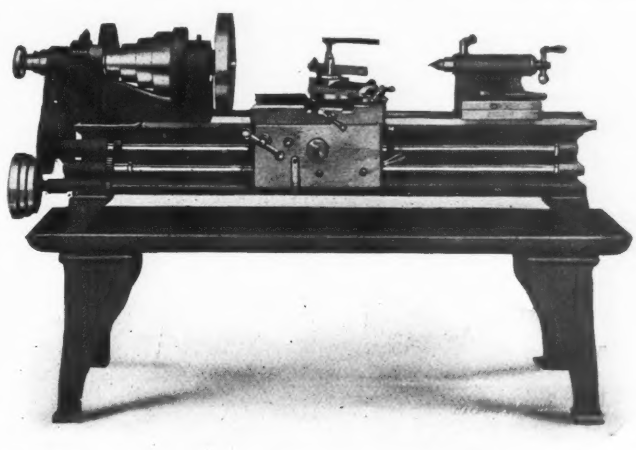
The headstock of this grinder has a graduated swivel base which can be adjusted along the table. A taper pin positively locates the head parallel to the table for cylindrical grinding. A central cam binder at the rear clamps the head and base to the table, and an auxiliary cam binder at the left end serves to clamp the head to the base and hold it firmly in position when the rear binder is released for adjusting the head. A simple clutch mechanism on the headstock enables the spindle to be started and stopped instantly, without interfering with the overhead countershaft. Combined with this clutch mechanism, there is a locking device for the spindle, which is particularly useful when tightening collets. The same lever that is used for engaging and disengaging the clutch serves to lock the spindle.

In order to adapt the machines for external grinding, the table is made with a swivel top which is secured to the lower member by cam binders located at each end. These grinders are built in the sizes, designated as the Nos. 3 and 4. The No. 3 size, which is the smaller, has a table 29 inches long, a stroke varying from 0 to 4 inches, a swing of 9 inches, and the weight is 900 pounds. The general construction and arrangement of the No. 4 grinder is very similar to the No. 3 size. The length of the table is 34 inches, the stroke ranges from 0 to 6 inches, the swing is 9¼ inches, and the weight, 1300 pounds.

One of these grinders arranged with a headstock, tailstock and grinding spindle for external work, is shown in Fig. 2. The general dimensions, stroke and arrangement of the driving and feed mechanisms are the same as for the No. 3 internal grinder illustrated in Fig. 1. This external machine is especially adapted for the rapid grinding of small shafts, studs, and similar work which is revolved on centers. Fig. 3 shows a No. 3 ball race grinder used in the production of radially ground ball races, etc. This machine is fitted with the same type of high-speed spindle used on the regular internal type. The work-holding head is mounted on slides which form a part of the hand-operated swivel member attached to the table. This swivel member has a broad supporting base and a long taper bearing which extends downward through the table. A pivoted holder for the diamond trimmer is supplied for forming the emery wheel to the proper radius, and provision is made for locating the work in the exact position for grinding. These machines are furnished with or without a base.

MIAMI VALLEY 14-INCH LATHE

The Miami Valley Machine Tool Co., Dayton, O., is now manufacturing the design of 14-inch lathe shown in the accompanying engraving. This lathe is designed for manual training schools and automobile garages, as well as for general manufacturing plants. The actual swing over the bed is 14¼ inches. The spindle, which runs in large phosphor-bronze bearings, can be equipped with a draw-in attachment and



Miami Valley 14-inch Lathe

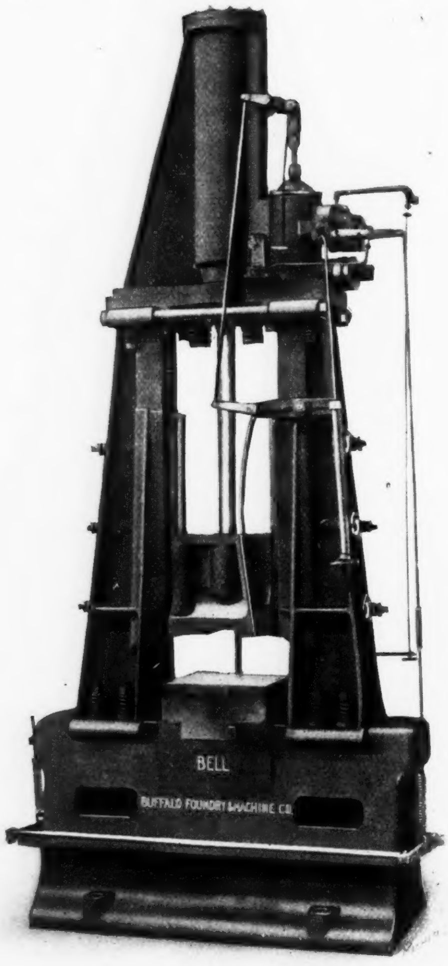
collets. The lathe can also be provided with a taper attachment, thus adapting it for tool-room work. The carriage has three bearings on the bed, the third bearing giving additional strength to the heavily ribbed cross-bridge. All the bearings are hand scraped. This lathe can also be furnished without an oil pan and with the regular style legs.

BUFFALO STEAM DROP-HAMMER

The Buffalo Foundry & Machine Co., 63 Winchester Ave., Buffalo, N. Y., has designed a new line of steam drop-hammers. A 1500-pound size, having a cylinder 10½ inches in diameter and a stroke of 42 inches, is illustrated herewith. The anvil base of this hammer is an open-hearth steel casting, the weight of which, as compared with the weight of the falling parts, is approximately in the ratio of 20 to 1. The lower die-holder is a hammered steel forging and is secured to the anvil base by a heavy steel tapered key. The frames or columns of the machine are open-hearth steel castings having recesses into which adjustable V-shaped guides are snugly fitted for guiding the hammer head. These guides have a taper gib between them and the column for taking up wear. The hammer head, of vanadium steel, is of ample length. The piston and its rod are made from a solid nickel-chrome vanadium steel forging, having an elastic limit of 85,000 pounds and a tensile strength of 120,000 pounds. This forging is carefully heat-treated before machining. The frames are held at the top by two cross tie-bolts and a steel cap-plate, the outer end of which is gibbed both to the cylinder and the frame. The cylinder is heavily proportioned and strongly ribbed.

The valve motion is of the well-known balanced piston valve

type and has a removable sleeve in the piston valve chest. Expansion or stuffing-box joints are provided for the steam and exhaust pipes, and the exhaust pipe is arranged so that no water can remain in the bottom of the steam cylinder. The hammer has an automatic force feed oil pump which forces the oil into the throttle valve chest. This oil pump is operated by the movement of the hammer itself. The throttle valve chest is provided with a by-pass so arranged that after the throttle valve is closed, the by-pass will allow just enough steam to enter the cylinder to hold the hammer head at the top of the stroke; or, if desired, the amount of steam can be increased in order to keep the hammer operating on a very short stroke at the top. The by-pass can also be closed entirely, thus allowing the hammer to come to rest. The columns are securely attached to the base-plate and to each other, as well as to the cylinder at the top. The distribution of metal throughout the design has been worked out very carefully to enable the hammer to withstand the hard and unusual strains encountered in steam drop-hammer work.



Buffalo 1500-pound Steam Drop-hammer

BROWN ELECTRIC RECORDING INSTRUMENT

A new type of electric recording instrument especially adapted for use as a recording electric pyrometer, recording volt-meter, or ammeter, has been designed by the Brown Instrument Co., Philadelphia, Pa. This instrument is intended to be mounted on the wall or switchboard, and the general arrangement is such that it can be used by an inexperienced workman.

The principal parts are mounted on the door instead of in the case, so that the recording pen is entirely out of the way when the chart which receives the record is changed; consequently, there is no danger of bending the pen when removing the chart. The clock mechanism and chart remain in the case, and, as soon as the door is thrown open, the entire voltmeter system and the inking device are swung aside with it, thus permitting the old chart to be easily removed and a new one substituted. Fig. 1 shows this recorder with the door closed and ready for operation, while Fig. 2 shows the door open for the insertion of a new chart. The millivoltmeter system which is used in this recorder is a simplified form of the D'Arsonval system.

In the operation of the instrument, the recording pen comes in contact with the paper momentarily only, thus producing a dotted line and eliminating friction between the pen and chart. An inking pad is placed beside the pen, carrying sufficient ink for a week's supply, and this pad touches the pen point frequently, thus keeping it damp. When the door is closed, the arm seen at the left in Fig. 2 (which is operated by the clock mechanism), comes in contact, automatically, with the inking device, and every half minute, or quarter minute, if preferred, it pushes the inking pad away from the pen permitting it to swing freely. The arm then falls, allowing the inking pad by its own weight to press the recording pen against the paper.

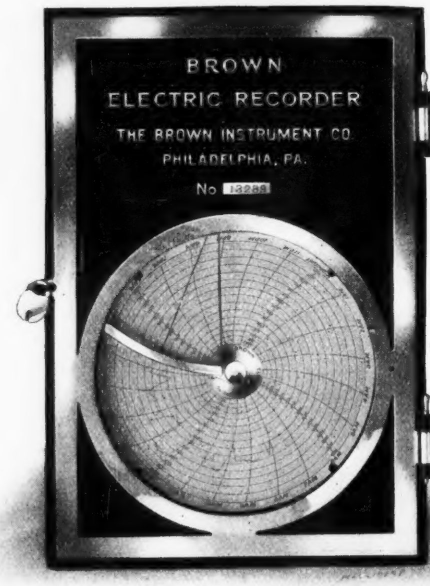


Fig. 1. Brown Electric Recording Instrument

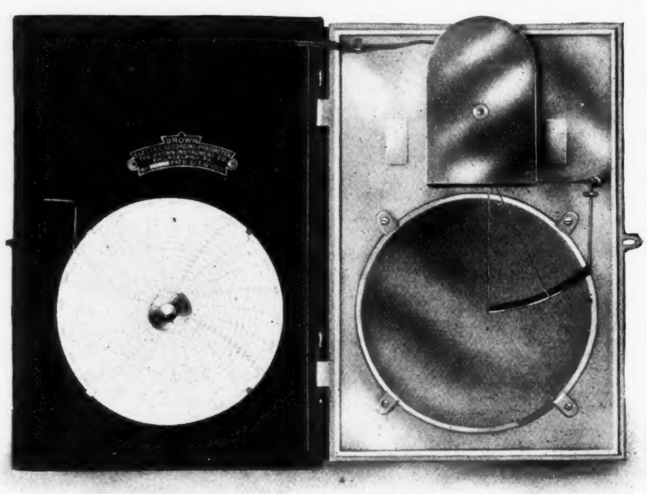


Fig. 2. Electric Recorder with Door Opened

The general arrangement of this new recorder is very simple, as the illustrations show; this is a particularly desirable feature for instruments of this kind.

DERIHON HARDNESS TESTING PRESS

In the April, 1910, number of MACHINERY, a Derihon portable ball press for testing the hardness of metals was illustrated and described. This machine was designed for laboratory work and is not intended for general use. Another type of Derihon press has now been brought out, which is especially adapted for shop use. It is very strongly constructed and is practically "fool-proof," there being no parts

to get out of adjustment or become deranged. This new design, which is illustrated in Figs. 1 and 2, has been placed on the market by H. A. Elliott, 507 Majestic Building, Detroit, Mich., who is the American representative of the G. Derihon Forge Works, of Loncin, Belgium.

This machine operates on the Brinell principle which, in brief, consists in forcing, with a standard pressure, a hardened steel ball, of standard diameter, into the metal being tested. The diameters of the impressions made by the ball in the different metals tested are then measured for comparing the hardness. This machine is very simple in its operation as well as in its construction. The hardened ball *B*, Fig. 2, which is forced into the part being tested, is held in a yoke *A* by a cap screwed on the end as shown. This yoke is suspended from a counterweighted arm *C* by a ball and socket connection giving a universal movement. Passing through the yoke and resting on its lower end, there is a lever *D*, which is fulcrumed at *c* and carries a grooved pulley at the rear. Passing over this pulley is a small cable *E*, attached at *a* to a circular counterweight *F*, which is free to swing eccentrically about pivot *H*. The other end of this cable is fastened to a windlass *G* which is connected through gearing with a crank *K*.

The piece to be tested is placed on the screw *L* which is then adjusted vertically, high enough to bring the part into contact with the ball. The weight *F* is then raised by turning crank *K* and this imparts a downward pull on lever *D*, which forces the ball against the part being tested. The weight of counterweight *F* has been calculated so as to give a load of 661 pounds at *e*, and as the length *c–e* of the lever is ten times the distance *c–d* between the pivot and fulcrum, the ball receives a pressure of about 6610 pounds. The function of the counterweighted compensating lever *C* is to maintain the yoke *A* in a vertical position.

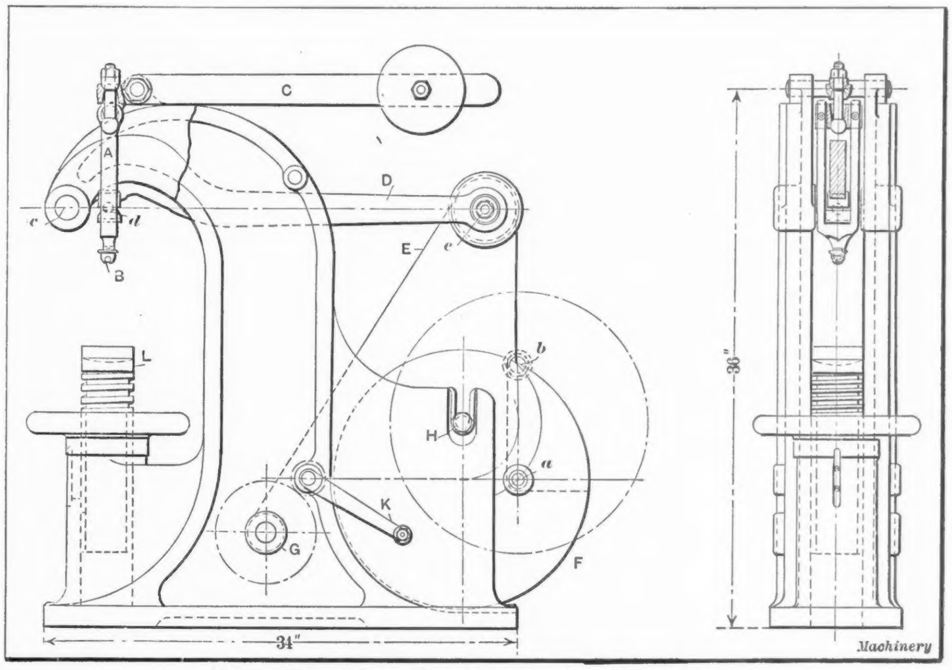


Fig. 2. Side and Front Elevations of Hardness Testing Machine

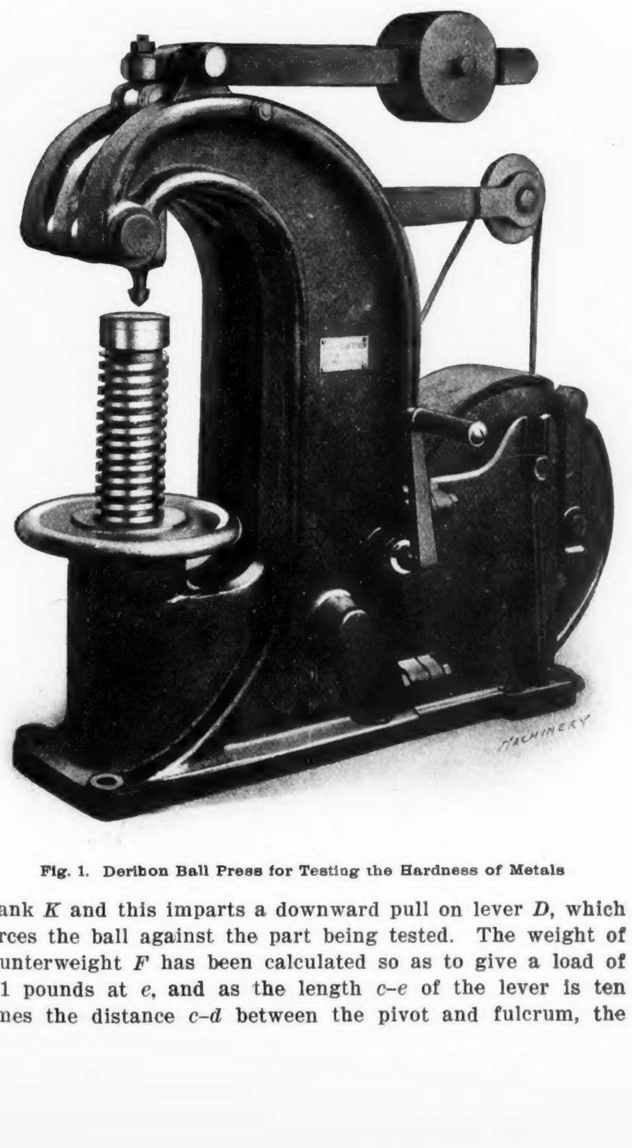


Fig. 1. Derihon Ball Press for Testing the Hardness of Metals

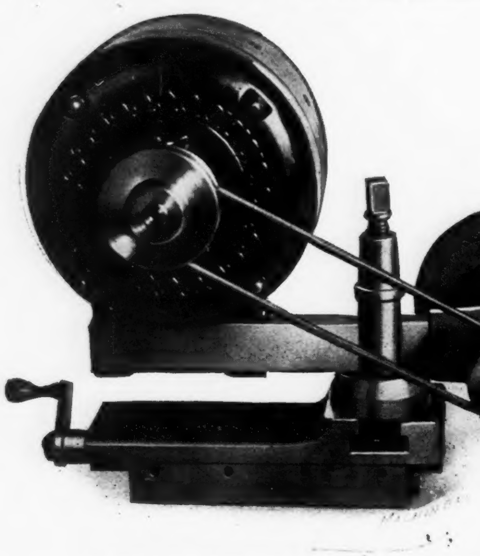
In order to secure accurate tests which will enable a true comparison of the hardness of different materials to be made, there are two conditions which must be fulfilled. The pressure on the ball must be applied gradually, and after it has reached the required maximum, it must be maintained without any fluctuation. The method of obtaining this gradual application of pressure and then a constant load, is very simple. When the circular counterweight *F* is raised by turning windlass *G*, the weight is rotated about the eccentric axis *H*, and the point *a* where the cable is attached, passes gradually through the arc shown, to position *b*. At the beginning of this movement there is no load on cable *E*, but when point *b* is reached, the cable supports the entire weight of *F* which is imparted to lever *D*. It will thus be seen that during the movement from *a* to *b*, which requires three turns of the crank *K*, the load of the counterweight is gradually removed from the pivot *H* to the cable, and, finally, the entire load of 661 pounds is supported by lever *D*. The second requirement of a constant load, fulfills itself. If the operator continues to turn crank *K* after the counterweight has reached position *b*, the load will not be increased above the required maximum, as the continued movement would only result in raising counterweight *F*, which is pivoted in an open slot, without increasing the load.

This machine is very strongly built, and weighs about 1057 pounds. It can be quickly operated without producing any shock whatever, which is an essential point in a testing machine. At the Derihon plants in Belgium and France, this type of machine has been in operation for over a year and has given satisfactory results. It is also in use in England and Germany.

MOTOR-DRIVEN LATHE CENTER GRINDER

The small grinder shown in the accompanying view is intended primarily for grinding lathe centers, though it can also be used for cutter and reamer grinding, etc. The grinder is shown in position on the compound rest of a lathe. The motor is mounted on an extension of the bar which carries the grinding spindle, and it drives the wheel by an endless belt, operating on grooved pulleys. This arrangement permits the use of a standard motor, and the emery wheel can be operated at any desired speed by the use of the proper size pulleys. The emery wheel is not affected by vibration from the motor, as it is when mounted directly on the motor shaft. The wheel is traversed at the proper angle for grinding centers, by swiveling the compound rest and using the regular screw feed.

The centers of lathes having plain rests can be ground by taking a succession of cuts equal to the width of the wheel. A tooth rest is furnished for grinding milling cutters, ream-



Motor-driven Center Grinder mounted in Toolpost

ers, etc. This grinder is built in two sizes having wheels ¼ by 4 inches and ⅜ by 6 inches, respectively. It is manufactured by the Willey Machine Co., Jeffersonville, Ind.

PRENTICE BROTHERS RADIAL DRILLING MACHINE

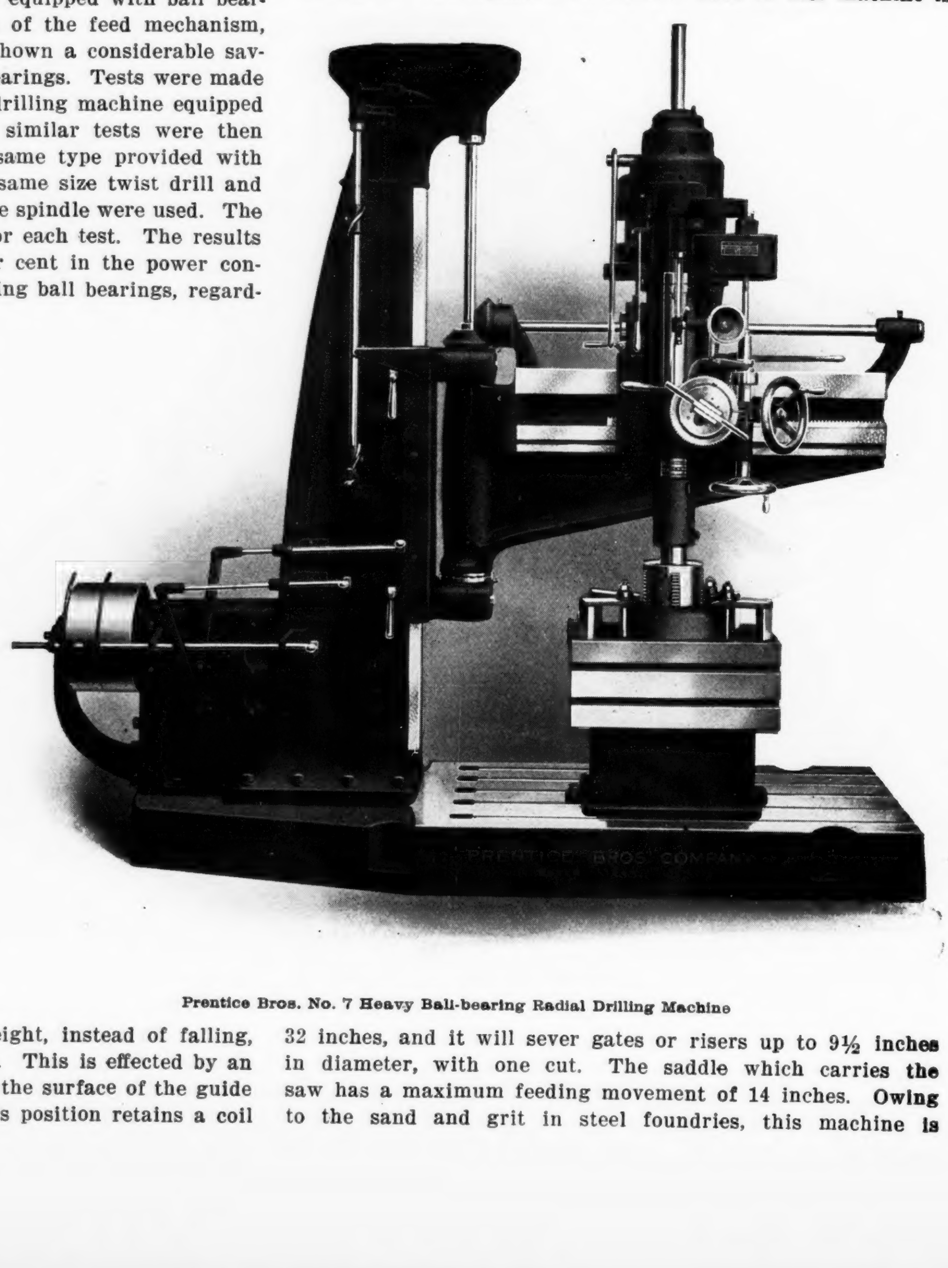
The Prentice Bros. Co., of Worcester, Mass., has brought out a radial drilling machine that embodies several new and important features. The machine is equipped with ball bearings throughout, with the exception of the feed mechanism, and carefully conducted tests have shown a considerable saving of power as the result of these bearings. Tests were made on a 26-inch upright all-gear-driven drilling machine equipped with ball bearings throughout, and similar tests were then made on a 26-inch machine of the same type provided with bronze bearings. In both cases the same size twist drill and corresponding feeds and speeds for the spindle were used. The material drilled was also the same for each test. The results showed a saving of at least fifty per cent in the power consumption when using a machine having ball bearings, regardless of the size of the twist drill used. The same results were also obtained from tests made on a radial drilling machine.

As an illustration of the power of this new design, an 8-inch pipe tap was securely fastened to the spindle nose, as shown in the illustration, so that the end of the tap just entered a straight hole in a flange 3 inches thick; then without any difficulty, the tap was driven through the 3-inch flange, not only cutting the thread, but also reaming its own taper from the straight hole in the flange.

In the design of this machine, the protection of the operator has been carefully considered, guards and safety devices having been incorporated at all dangerous points. To eliminate any possibility of injury by the unexpected falling of the spindle counterbalance weight, a simple but effective contrivance has been provided. If the weight chain should part, the weight, instead of falling, would be instantly locked to its guide. This is effected by an eccentric part that is held away from the surface of the guide by the weight itself, and while in this position retains a coil spring under tension. In case the chain breaks, the coil spring acts on the eccentric, forcing it against the notched side of the guide. A safety stop motion for the vertical adjustment of the arm is also provided, so that if the saddle should accidentally be moved too high or too low, the tumbler gears at the top of the column would automatically be disengaged. This disengagement is effected by a finger securely fastened to the saddle that comes in contact with the spiral surface of a cam on the regular shifter rod, thus disengaging the gearing.

This machine has sixteen spindle speeds, four of which are obtained by a speed box, this number being multiplied by four through changes obtained in the head. The back-gears together with the high- and low-speed gearing, give the four changes in the head. The high- and low-speed ratios are placed in the head so that when heavy work is being done, all the shafting and gears back of the head are relieved from excessive stresses, and when the spindle is operating at high speeds for drilling small holes, the shafts and gears are relieved from excessive speeds.

This design has eight geared feed changes, friction backgears, and a friction tapping attachment which may be engaged or disengaged while the machine is in motion. There is also a quick-return device and automatic stop motion, a patent roller clutch which will permit feeding by hand ahead of the engaged power feed, and a dial depth gage which always reads from zero. The gearing is all carefully guarded. Suitable and efficient binding devices are provided, as well as permanently located wrenches, and the operating levers are centrally located.



Prentice Bros. No. 7 Heavy Ball-bearing Radial Drilling Machine

NEWTON COLD METAL SAWING MACHINE

A cold saw designed especially for steel foundries is shown in Fig. 1. The diameter of the saw used in this machine is 32 inches, and it will sever gates or risers up to 9½ inches in diameter, with one cut. The saddle which carries the saw has a maximum feeding movement of 14 inches. Owing to the sand and grit in steel foundries, this machine is

fitted with exceptionally large shears and the bearings are bushed where necessary. The spline shafts are also fitted with collars which rotate with the shafts in the bearings and prevent the escape of oil.

The spindle revolves in bushed capped bearings and it is supported at each end. The driving spindle gear is mounted between these bearings as shown in Fig. 2 which illustrates the driving mechanism. The spindle is fitted on the saw end with three circular keys for driving the blade and there are, in addition, three bolt holes for holding the blade to the flange. On the opposite end of the spindle, adjusting nuts are provided for taking up wear. The drive to the spindle is by means of broad steel gears, and the teeth of the driving pinion meshing with the spindle gear are cut on the solid worm-wheel shaft as shown. The driving worm-

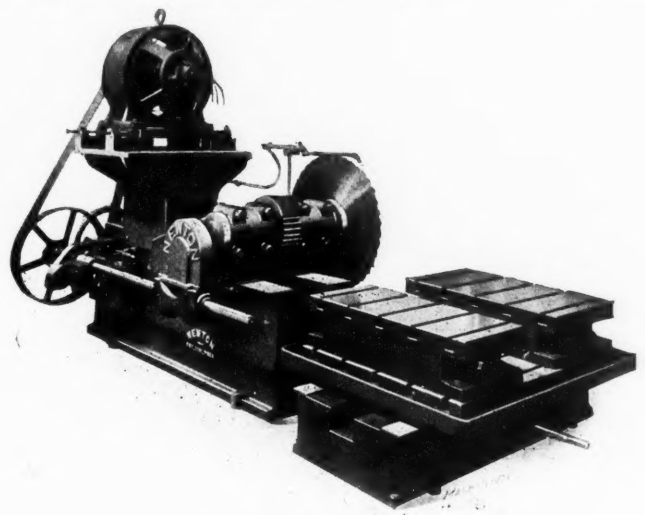


Fig. 1. Newton Cold Saw for Steel Foundries

wheel is a solid bronze casting and the driving worm is of hardened steel. Both the worm and worm-wheel are encased for continuous lubrication.

The saddle is of heavy construction and has square bearings on the base with under-locking gibs cast solid, and the adjustments are made by taper shoes. The saddle is fitted with an adjustable automatic safety release for the feed, and a fast traverse. The feed-screw has a bearing

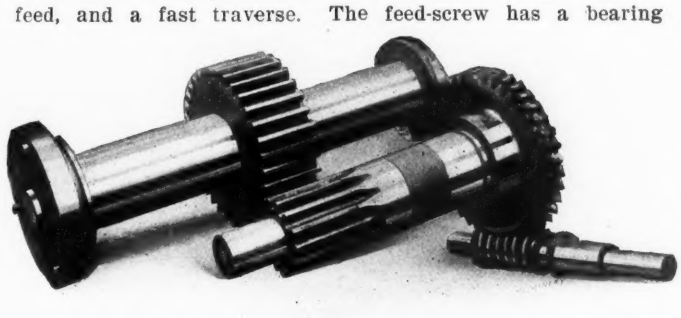


Fig. 2. Saw Spindle-driving Mechanism

at both ends so that it is always in tension. The machine is fitted with a geared feed having six changes and a quick return. By the use of a double-throw switch or reversing motor the fast power traverse is available in either direction. The driving motor of this machine is mounted on a bracket that can be adjusted to vary the tension of the belt. The particular saw illustrated is driven by a Fairbanks-Morse ten-horsepower induction motor, operating at 1200 revolutions per minute.

The work-table is 36 inches wide by 48 inches long and is entirely surrounded by an oil pan. It has a hand cross adjustment of 20 inches. The auxiliary parallels for supporting the work are each 16 inches wide, 36 inches long and 9 inches high. These parallels permit clamping the work close to the saw-blade on each side, which is particularly desirable when making two cuts in one piece at the same setting. During tests, this machine made a number of cuts through a 5½-inch steel bar (0.35 carbon) in one minute and thirty-five seconds. This sawing machine is built by the Newton Machine Tool Works, Inc., Philadelphia, Pa.

WASHBURN MULTIPLE SPINDLE DRILLING MACHINE

The multiple spindle sensitive drill press illustrated herewith is manufactured by the Washburn Shops of the Worcester Polytechnic Institute. This machine is equipped with a belt tightener which allows an instantaneous variation of the tension, the latter being controlled by automatically locked tighteners operated through a rack and pinion. The countershaft is made a part of the machine, being located at the rear of the column. The drive from the countershaft is by an open belt to a jack-shaft and then by quarter turn to the spindle pulley. Both the countershaft and the jack-shaft are provided with ring oiling bearings.

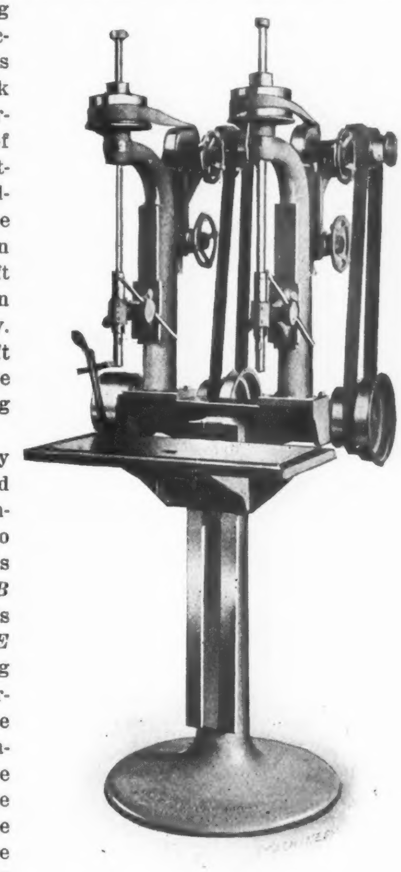


Fig. 1. Washburn Multiple Spindle Drill Press

The spindle pulley runs in an oil bath, and is of an entirely new construction. Referring to Fig. 2, the pulley *A* is keyed to the spindle *B* at *C*. The quill *D* is driven into the column *E* at *F*, the column having been bored for this purpose in line with the head bracket. The tension of the belt on the pulley is taken by the quill so that the spindle runs absolutely free. The flange *G*, instead of being a part of the pulley, is made a part of the quill. Concentric with the bearing *D* and within the pulley there is a ring *J*. The space between this ring and the bearing *D* forms an oil cup, and therefore the bearing *D* is always flooded with oil. This ring also acts as a retainer and prevents the oil from spattering.

The machine has a capacity for holes up to 9/16 inch in diameter and the spindle is bored to fit a No. 1 Morse taper.

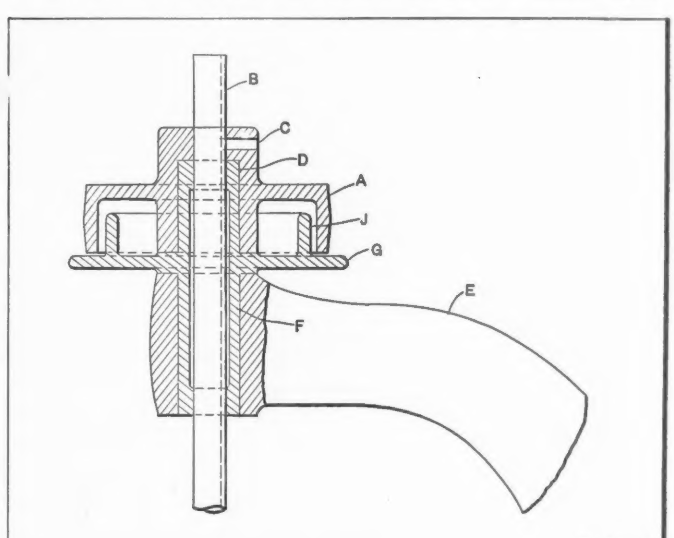


Fig. 2. Sectional View of Spindle-driving Pulley

With the recommended speed of 610 revolutions per minute for the countershaft, the spindle speeds are 610, 1016 and 1830 revolutions per minute. The two-spindle machine weighs 715 pounds. The greatest distance to the spindle is 40 inches, and the distance from the center of the post to the center of the

spindle, 8 inches. The spindle feed is 3 inches. The size of the table is 14 by 28 inches. This design is made with two, three and four spindles.

DRESES RADIAL DRILLING MACHINES

The design of plain radial drilling machine shown in Fig. 1 is a recent development of the Dreses Machine Tool Co., Cincinnati, O. These radials are built in 5-, 6- and 7-foot sizes, the particular machine illustrated being a 6-foot size. One of the important improvements of this design is the addition of a third bearing for the head. This third bearing, which is formed in the back-gear bracket as shown in Fig. 2, gives additional support to the head and prevents bending or straining the rear shaft and rapid wear of the bevel gears and their bearings. It also distributes the torsional strain over the whole arm. The head has long and wide bearings on the face of the arm as well. The clamping and releasing of the head is done by a single handle which is located on the left side. By means of a compound spiral gear arrangement, the head is easily traversed on the arm. Another noteworthy improvement is the provision of a ball bearing on which the spindle driving gear rests and revolves, in order to reduce the friction to which this gear is subjected on account of the pull exerted on it when the spindle feeds down.

The spindle runs in phosphor-bronze bearings contained in a steel sleeve, and the feeding rack is cut directly into this sleeve to bring the pressure close to the center. The all-geared feed mechanism is entirely enclosed, and provides eight changes which are varied by the small handle seen on the feed shaft and multiplied by the crank directly above it. Both of these controlling handles are within convenient reach. The feed worm runs in an oil bath. The quick-advancing and return device has four levers any one of which engages or disengages the feed instantly, and these levers also form a pilot wheel for operating the spindle by hand. By means of a ratchet clutch, the hand feed works

Fig. 1. Dreses 6-foot Radial Drilling Machine

ahead of the power feed. The automatic stop and depth gage has a swinging dog attached to an extension on the spindle sleeve, which is brought into contact with an adjustable dog on the feed bar. Fixed to this adjustable dog is a graduated scale by means of which a predetermined depth of hole can be gaged from zero. When holes of different depths are to be drilled, several dogs can be placed on the feed bar; these are then successively engaged with the swinging dog. A safety release for the end of the feed is provided.

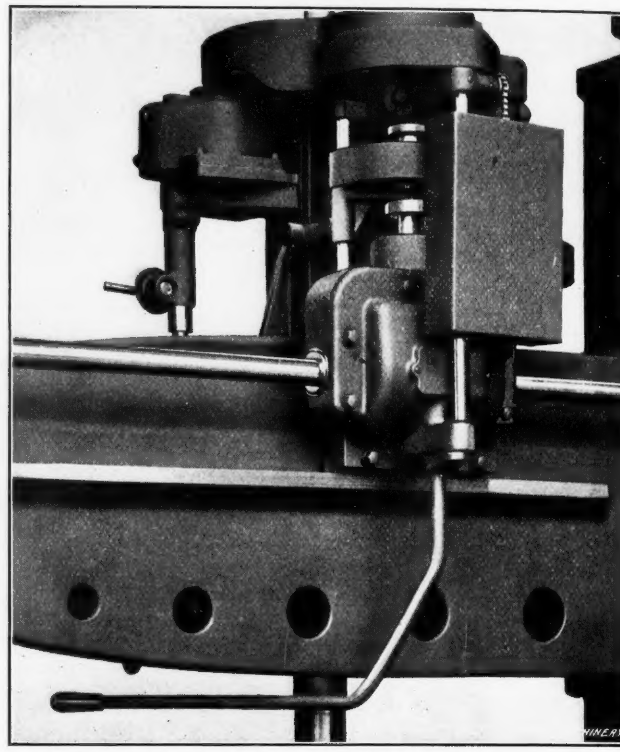


Fig. 2. Rear View of Head showing Third Bearing on the Arm

The starting, stopping and tapping mechanism is of the friction type. It is embodied in the head and operated by the horizontal lever seen below the arm. The friction bands are double expanding, and of large diameter. They are made of phosphor-bronze to avoid cutting. The bevel gears containing the frictions run in an oil bath. The backing out of a tap can be accelerated in a ratio of 2½ to 1 by the speed changing lever in the head.

The head has three speed changes, giving a total of twenty-one changes to the spindle. The arrangement is patterned after automobile transmission gearing, and the changes can be made while the machine is running. The speed variator at the rear of the column is of the well-known tumbler gear type and gives seven changes. It is provided with this company's self-releasing over-take clutch, and the gear teeth are of the 20-degree involute pointed form, giving strength and easy engagement.

The arm is a box parabolic shape. The elevating mechanism is controlled by a conveniently located handle, and there is an automatic knock-out at the top and bottom. The thrust of the elevating screw is taken by a ball bearing. The outer column of this machine swings on an inner fixed column which extends nearly to the top, and there is a third central bearing which increases the rigidity of the swinging member. Both the fixed and swinging columns are enlarged at the lower end which provides room for a large roller bearing and insures firm and easy clamping. No pressure is exerted on the taper rollers of the column bearing, in clamping, and they are protected from chips and dust by a cover.

The power and rigidity of this new design is indicated by the following tests: An 8-inch pipe tap was driven through a 2½-inch plate, as indicated in Fig. 3, by the 6-foot machine, and during another test a 4-inch high-speed drill,

operating at a cutting speed of 100 feet per minute, was forced through cast iron with a feed of 0.027 inch per revolution. In accordance with modern practice, all bevel gears are planed, and the spur gears are cut with special cutters. The pinions

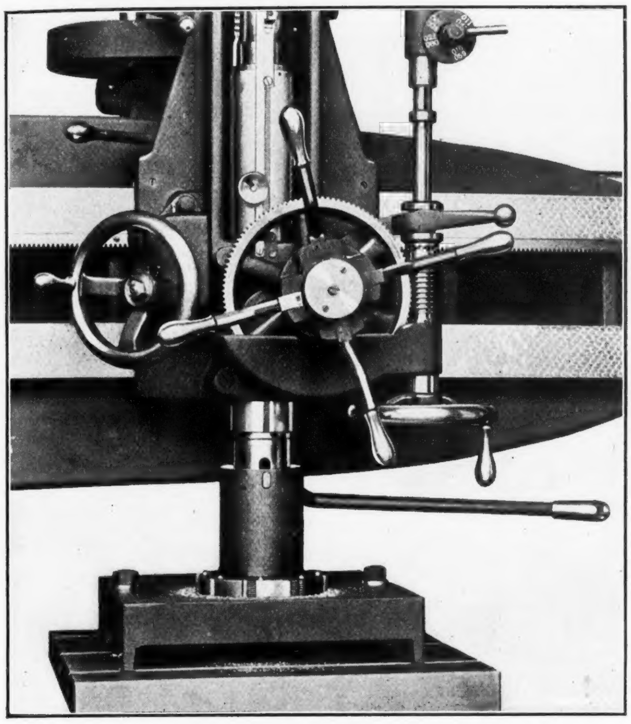


Fig. 3. Dreses Six-foot Radial driving an Eight-inch Pipe Tap

and small gears are made of forged steel and hardened, and other gears subjected to severe duty are of crucible cast steel. All bearings have removable phosphor-bronze bushings, and the gears are all covered.

BATTERY TRUCK CRANE

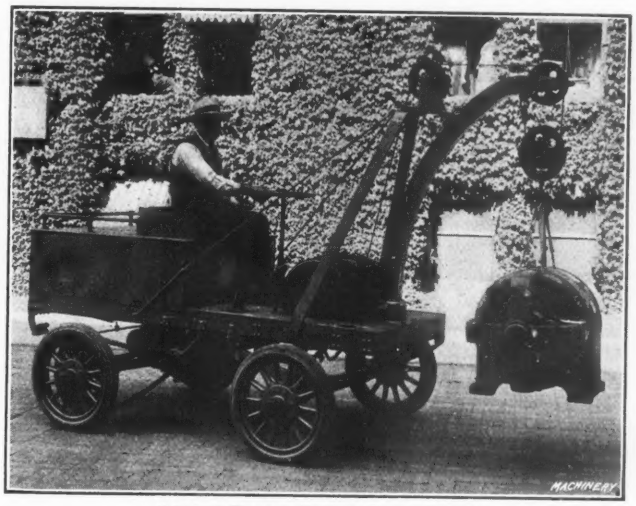
The battery truck crane is a device for handling expeditiously and at low cost freight or any materials within its capacity whch have to be lifted and moved through moderate distances. This crane, which is shown in the accompanying view, is applicable to manufacturing plants and many other places, such as railway and machine terminals, etc. It is the product of the General Electric Co., Schenectady, N. Y. The crane proper is mounted on the front end of an electrically propelled car. The crane is free to swing, and its hook is raised and lowered by a 1-ton hoist located at the rear of the base. The motors for operating the hoist and propelling the car are driven from a battery mounted on the rear end. This crane may be used effectively either for hoisting, hoisting and carrying on the hook, or for towing trailers.

In case the material, which may be sub-divided into parcels of one ton or less, has to be deposited within a 6- or 8-foot radius and this action does not require moving the load through a vertical distance of over 10 feet, the car is moved to an advantageous position, the brakes are set and the car remains stationary while the boom of the crane is moved back and forth between the "picking-up" and depositing points. In this manner the crane can be employed to load and unload railway cars, wagons, trailers, etc. As a practical example of what can be accomplished, 300 castings aggregating 65,000 pounds were unloaded from a gondola in five hours, giving an average of 1.2 lift per minute. As another illustration, a box car was loaded with sixty-four 800-pound barrels of plumbago in twenty-five minutes, and four cars were loaded in two and one-half hours, which included "spotting" the cars.

When material in small or large quantities has to be moved less than 400 feet, or in small quantities to any distance, the article is lifted by the hook, conveyed to its destination by the car and deposited on the floor or wherever desired. The short wheel-base of the car permits making short turns, so that the car can be driven about shop aisles or around piles of material in a storage yard. The flexibility and speed of the crane adapts it to factories, even though they are fully equipped with ordinary cranes and an industrial railway By this "pick-up-and-run" system, sixty 800-pound barrels of plumbago were moved 300 feet in one hour, one helper only being required. In a store-room, boxes of angle and flat iron weighing about 1000 pounds each, were stacked in assorted and orderly piles at the rate of forty boxes an hour.

For the miscellaneous transfer of large quantities of material through a distance of over, say, 400 feet, the battery truck crane can be used for towing trailers in trains of about four. Where the quantity of material removed is large enough to warrant it, two or more trains can be used advantageously in order to eliminate any waiting at the junction points. For example, as soon as one set of trailers is delivered, the car immediately starts with the empty trailers that were brought on the previous trip. The number of trailers per train and the number of trains to get the most efficient operation would, of course, depend on the distance, character of the load, and time required for loading and unloading.

This crane is designed to give a high draw-bar pull, its maximum pull being 2000 pounds, which is equal to that of a five-ton locomotive on rails and is sufficient to "spot" a car and to readily handle loads of from five to eight tons on trailers. Trailers of special design having a capacity of three tons are employed in this work. The wheels are 24 inches in diameter, have a 5-inch face width, and are equipped with roller bearings. The deck is 12 feet long, 4 feet wide and is 29 inches from the ground. The crane is equipped with special attachments to suit the character of the work. These consist of rope and chain slings, barrel tons, bale grapples, box hooks and snatch blocks. For special work, other equipment is designed and built to meet individual requirements. The height of the crane can also be made to suit local conditions, and booms of different lengths can be supplied. The trailers can also be modified to suit



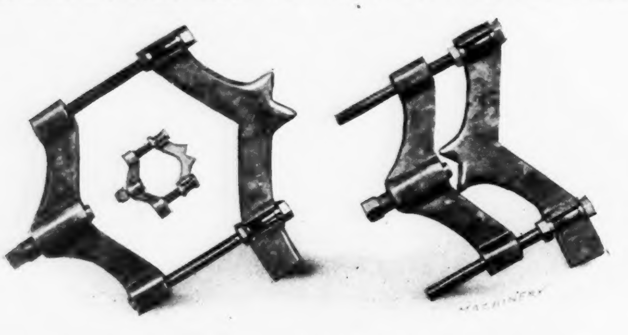
General Electric Battery Truck Crane

elevations and other limiting features. This crane has all the advantages of an electrically operated car. It is odorless, practicaly noiseless and is free from explosions which might cause fire. The battery charging may be left to a night watchman. Where direct current is available, a simple panel and rheostat serves for charging apparatus, and for alternating current a rectifier panel is used to transform the current before charging.

BARTER GRINDER DOG

The grinder dog shown in the illustration is provided with a double jaw, the position of which can be reversed to adapt the dog for large or small work. This jaw has a large vee on one side and a small one on the other, so that by simply changing the position of the jaw, as shown in the view to the right, very small work can be held. The two drop-forged parts which form the dog are held together by side screws that provide additional adjustment. These screws are held in place

by check-nuts which prevent them from shifting after they are set to a given size. These dogs are made in four sizes having capacities up to 1½ inch, 2½, 4 and 7 inches. The three largest sizes are brass lined. The binder screw also has a brass



Grinder Dog having Reversible Jaw which adapts it to Large or Small Work

tip which is held in place by a pin passing through the screw. The faceplate driving pin bears against a projection on the reversible jaw. This dog is made by T. S. Barter, 1 Holt Ave., Worcester, Mass.

SIBLEY ALL-GEARED DRILLING MACHINE

A box column all-geared drilling machine, built by the Sibley Machine Tool Co., 8 Tutt St., South Bend, Ind., is shown in Fig. 1 of the accompanying engravings. This machine has

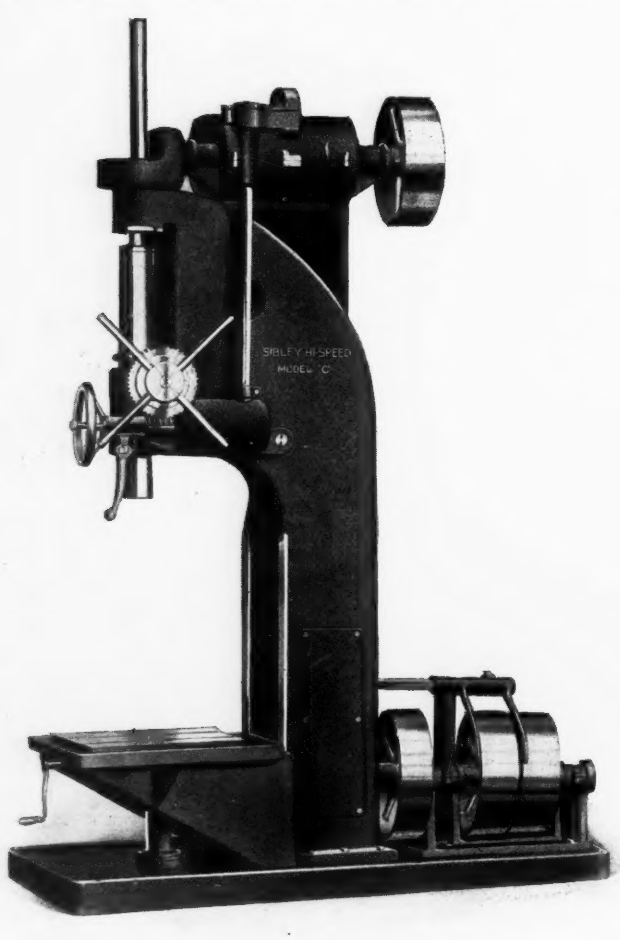


Fig. 1. All-geared Drilling Machine, built by Sibley Machine Tool Co.

a direct drive, the speed-box being located at the top of the column, and in the design, all parts not affecting the range or convenience have been eliminated. All gears are enclosed and run in oil, and all bearings are provided with self-oiling devices. The method of lubricating the crown gears is indicated by the sectional view, Fig. 2.

By locating the speed box on top of the column, only one pair of bevel gears is needed to deliver the power to the spindle. Any one of eight speeds can be selected instantly without running through the intermediate changes. Six long split bushings of special bronze, having ninety-seven square inches of bearing surface, carry the main gear shafts, which are made of high carbon steel. The entire mechanism operates in an oil bath, and hoods at the ends of the bearings catch the surplus oil which returns to the case through large drains.

The spindle is made of high carbon steel and is finished by grinding, as is also the graduated spindle sleeve. The spindle runs in two bronze bearings which have self-oiling devices and it is equipped with a ball thrust collar. The feed mechanism derives its power from the main driving shaft which directly rotates the spindle, and it is geared down in such large ratios that a powerful feed is obtained. The semi-steel feed gears are always in mesh, and changes are effected by means of a patented internal key which will not stick or bind. Four changes are obtained by moving a small knob in the center of the handwheel, and this knob also has a neutral position. The

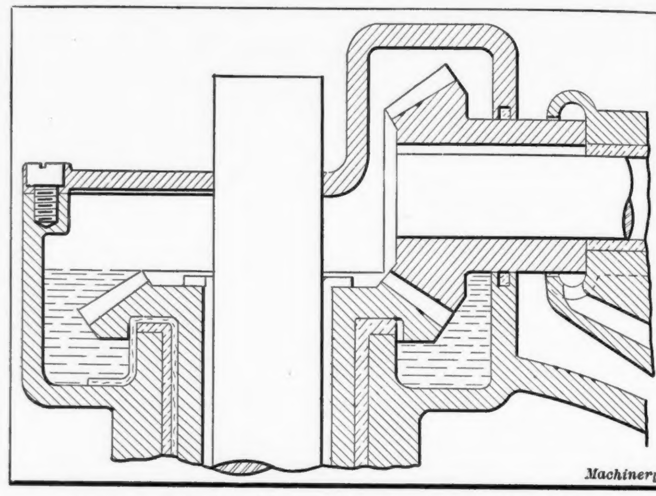


Fig. 2. Section showing Method of Lubricating Crown Gears

spindle has an automatic tripping mechanism for drilling to any predetermined depth. This consists of an adjustable collar on the graduated spindle sleeve, which trips a latch so that the entire mechanism swings down from the worm-gear on a large hinge pin. The worm-gear is made of a special bronze alloy.

The various controlling levers are so arranged that the starting or stopping of the machine or changes of speed and feed can be made from the operating position in front. The countershaft bearings have self-oiling devices, and a self-oiling loose pulley is provided. The pump and tank for supplying the lubricant to the cutting tool and all pipes are enclosed within the column, as shown in Fig. 3. The cutting compound returns to the enclosed tank through a drain in the table.

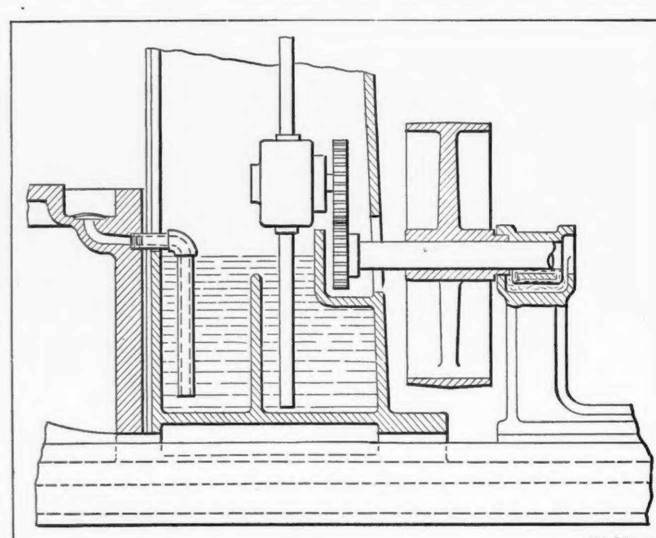


Fig. 3. Section of Column showing Oil Tank and Enclosed Pump

There are no exposed moving parts on this machine except the pulleys and spindle, and the various members have been designed to carry several times the maximum load.

This machine is guaranteed by the manufacturers to drive the best high-speed steel drills, varying from ¾ to 1¾ inch

in size, at their most efficient speeds and feeds. The principal dimensions are as follows: Swing, 24 inches; maximum distance from the spindle to the table, 27 inches; feed of the spindle, 12 inches; feeds per revolution of the spindle, 0.008 inch, 0.015 inch, 0.024 inch and 0.032 inch; smallest diameter of the spindle, $1\frac{3}{4}$ inch; diameter of the sleeve, $3\frac{3}{8}$ inches; working surface of the table, 16 by 20 inches; vertical traverse of the table, 20 inches; diameter of all pulleys, 13 inches; face width of all pulleys, $4\frac{1}{2}$ inches; spindle speeds, 75 to 450 revolutions per minute; height over all, 6 feet, 10 inches; weight, 2200 pounds; and floor space, 29 by 57 inches.

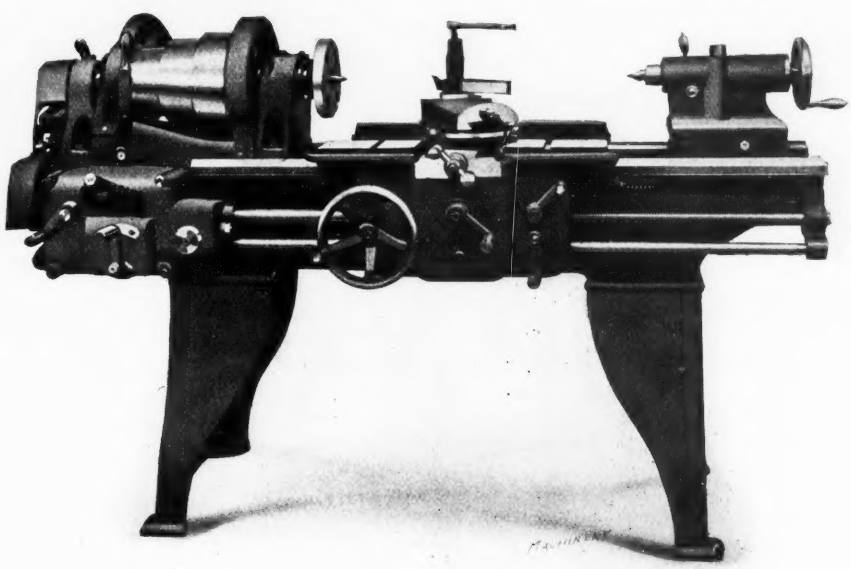


Fig. 1. Sixteen-inch Lathe, built by John B. Morris Machine Tool Co.

MORRIS SIXTEEN-INCH QUICK-CHANGE ENGINE LATHE

The John B. Morris Machine Tool Co., Cincinnati, O., is now manufacturing a new design of quick-change engine lathe. This lathe, a view of which is shown in Fig. 1, conforms in general to the practice of the leading lathe builders, but a number of features have been incorporated in the design for increasing the productive capacity.

The headstock, front and rear views of which are shown in Fig. 2, is reinforced with an improved system of longitudinal and cross ribs which extend down below the shears of the bed, and it is equipped with back-gears of the double-friction type. The ratios of these gears are such as to insure ample driving power. The frictions in the gears are of the toggle lever type and have an automatic adjustment for wear. The driving cone is three-stepped and is intended for a $3\frac{1}{2}$-inch driving belt. The spindle boxes are made of phosphor-bronze and are oiled continuously from large oil wells located in the pedestals. The front spindle bearing is $2\frac{3}{4}$ inches in diameter and $4\frac{1}{2}$ inches long. The reverse plate is mounted on the outside of the head, as the illustrations show, and it is a double-walled one-piece casting, supporting the gear studs at each end

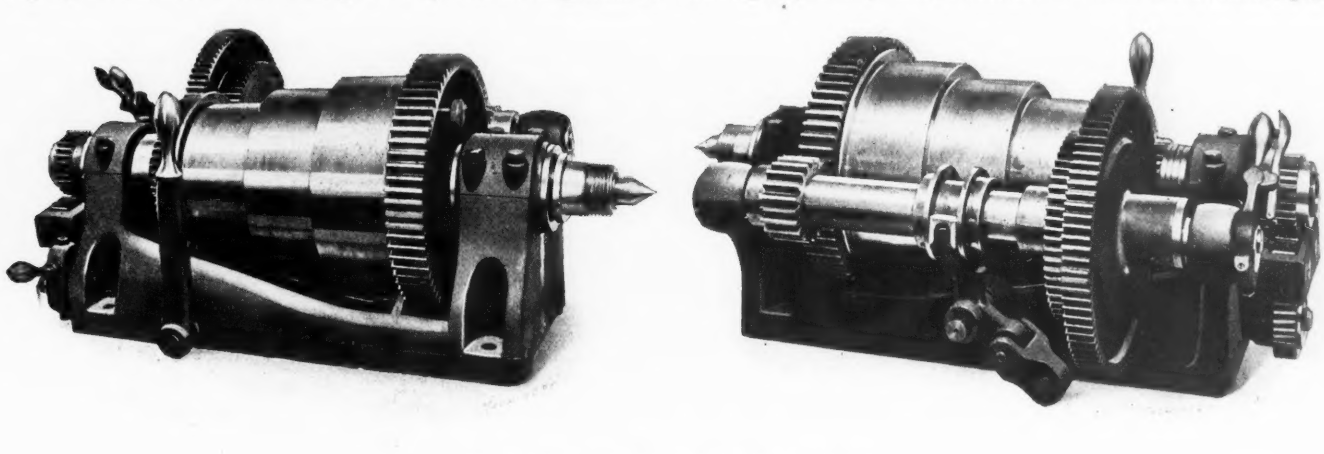


Fig. 2. Front and Rear Views of the Headstock

The quick-change-gear mechanism illustrated in Fig. 3, consists of the usual cone and tumbler-gear combined with a novel system of sliding gears through which forty-five changes for feeding or thread-cutting are obtained by the use of twenty-one gears. All the feed changes are controlled by means of the three levers seen at the front of the gear-box. The one at the left is only used to secure the extreme range. The total range of the machine for thread-cutting is from two to sixty threads per inch. The lathe is fitted with the usual quadrant and quadrant-gear for connecting with the spindle, so that it is possible, by the use of additional gears, to cut special threads if necessary. A new feature in connection with this mechanism is the method of engaging or disengaging the feed-rod and lead-screw. This is effected by means of a sliding gear operated by a knurled handle seen at the extreme right of the box, and the arrangement is such that when the lead-screw is in operation, the feed-rod is at rest and *vice versa.*

The quick-change box is a complete mechanism in itself, and can be taken off the bed without disturbing the adjustment of the lead-screw or feed-rod.

The apron (see Fig. 4) is a one-piece box section casting and all studs and gears are supported by bearings at each end. It is supplied with the usual bevel gear reverse mechanism which interlocks with the half-nut so that it is impossible to engage the lead-screw and feed-rod at the same time. To overcome the difficulty of manipulating the revolving knurls for engaging and disengaging the feeds, a novel arrangement of clutches is employed. These clutches have frictions of the expanding ring type, 5 inches in diameter, which are engaged by a toggle lever movement that insures ample driving power for the heaviest cuts. The shifting mechanism for these frictions consists of a single crank handle located at the center of the apron. When this lever is thrown to the right, it engages the longitudinal feed, and when it is thrown to the left, it engages the cross feed. Since this lever is stationary at all times, it enables the operator to work up to a shoulder without the necessity of throwing out the feed and running up the carriage by hand; and in addition it is in a convenient position for manipulation, at all times. There is a positive stop which makes it impossible to throw the lever from one feed to the other without first pulling out the plunger pin in the handle, which therefore cannot be shifted directly from the longitudinal to the cross feed position or *vice versa.*

The carriage, upper and lower views of which are shown in Fig. 5, has a bearing $26\frac{1}{2}$ inches on the bed, and is carried on a V at the front and on a flat surface at the back of the bed. It is held in position by a long flat clamp at the back and by means of two taper gibs at the front which bear on a machined

surface directly under the front V. These gibs, by their location, make it impossible for the carriage to lift, and they will not throw the carriage out of alignment if not properly adjusted. The front V is unusually large, being 1½ inch in

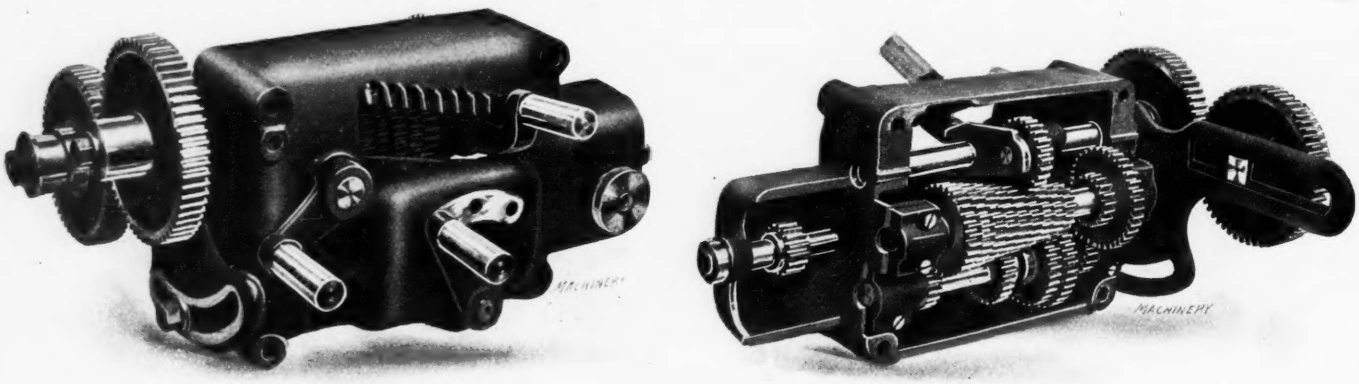


Fig. 3. Quick-change Mechanism giving Forty-five Changes

width, and the wide flat bearing at the back gives the carriage an exceptionally large bearing surface. The bridge is very wide and drops down in a deep double-box section between the shears. Since the ways for the tailstock are dropped down below the ways for the carriage, it is not necessary to notch the bridge for clearance.

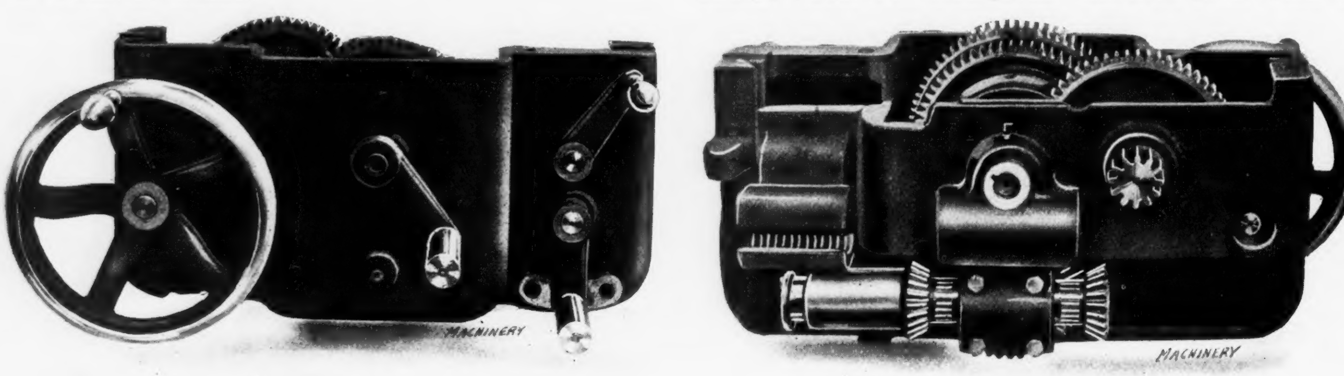


Fig. 4. Front and Rear Views of Apron

The compound rest is made heavy to withstand the strains imposed upon it by the modern high-speed steels. The clamping device for the swivel is operated by a single bolt which is so located as to be conveniently operated. The clamping mechanism consists of a V-shaped clamping ring similar to that usually found on round column radial drills. This device,

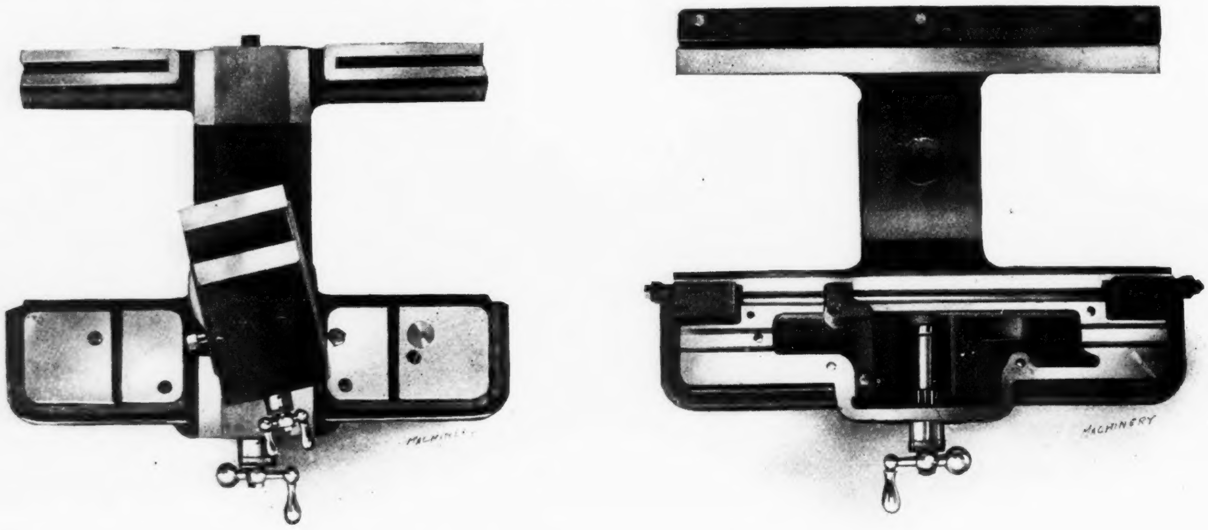


Fig. 5. Views showing both Sides of the Carriage

in addition to being very effective, leaves the bottom slide more rigid than it would be with the T-slot turned in it; at the same time the compound rest can be adjusted quickly.

The tailstock is very massive and is arranged with the usual set-over for turning tapers. Its spindle is of steel 2 3/16 inches in diameter and it is clamped by means of a taper plug of the same construction as that usually found on the overarm of milling machines. The tailstock is clamped to the bed by two large bolts which are directly in front of and behind the tailstock spindle. These bolts reach to the top of the tailstock, where the nuts are in a convenient place for the operator.

The bed is 11¾ inches deep and 14½ inches wide, and is strongly ribbed with cross girths. The front girth, which is directly under the front spindle bearing, extends clear up to the top of the ways in order to resist the twisting strain on the bed at this point. The legs are set in from the ends of the bed, as shown, thus shortening the span between supports on the bed and making use of the familiar cantilever form of construction.

The feed gears throughout the machine are made of steel and are exceptionally heavy, the lightest gear in this mechanism having nine diametral pitch. That the machine is capable of continuous operation under heavy cuts is indicated by the

statement that it will handle, without difficulty, a cut 1/4 inch deep in 0.60 point carbon steel, with a 1/8-inch feed, at a peripheral speed of seventy-five feet per minute.

This lathe swings 16 1/2 inches over shears and 10 inches over the carriage. With a six-foot bed it takes 2 feet 8 inches between the centers, and weighs, approximately, 2100 pounds.

CASEHARDENING EQUIPMENT

An oil furnace equipment designed and built by Walter Macleod & Co., Cincinnati, O., for the Warner Mfg. Co., of Toledo, O., is illustrated herewith. This equipment, which is for casehardening and heat-treating automobile transmission and steering gears, consists of five casehardening furnaces built in battery form, two heat-treating furnaces, one steel fan pressure blower directly connected to the driving motor, a rotary oil pump geared to the blower shaft, a multiple indicating pyrometer outfit, one 12,000-gallon oil storage tank, and a meter for determining the consumption of fuel.

The casehardening furnaces, which are shown in Fig. 1, have a capacity (at 1560 degrees F.), for 190 sets of transmissions per day of twenty-four hours. During this period there is an oil consumption of 840 gallons, which is equal to 4.4 gallons per set, so that each set, with oil at 2 1/4 cents per gallon, costs 9.9 cents. Each of these furnaces has a heating chamber 54 inches wide by 72 inches long. Granulated raw bone is used as a carbonizing material, and the average penetration obtained is 1/32 inch. The heat-treating furnaces (Fig. 2) are used for various classes of heat-treating work. These have an average oil consumption of 4 gallons per hour, and the heating chambers measure 32 by 49 inches.

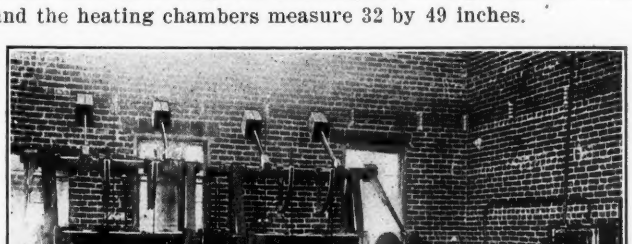


Fig. 2. Heat-treating Furnaces

All these furnaces are built of the best grade of firebrick, and are encased in heavy sectional, cast-iron ribbed plates, held in position by bolting strips and tie-rods in the usual manner. They are of the semi-muffled type, the combustion chamber occupying a position adjacent to the heating chamber. The gases are carried to the arch of the heating chamber, and after heating the material, pass into flues in the side walls,

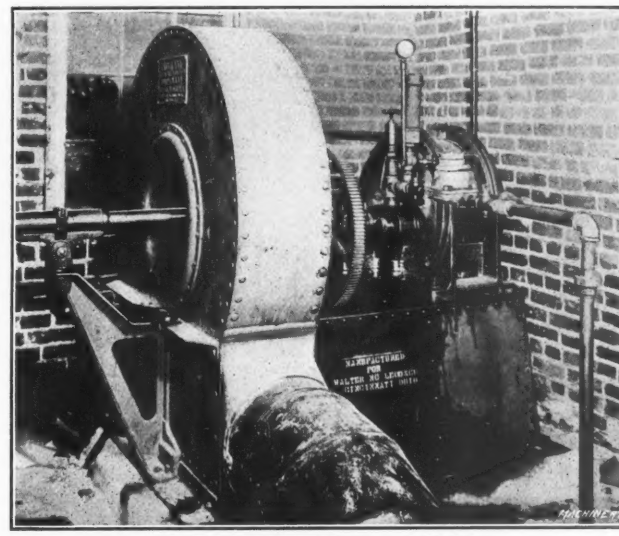


Fig. 3. Motor-driven Blower and Oil Pump

which lead under the hearth into the top of the furnace. As the natural tendency of hot gases is to rise, combustion chambers are usually built on or below the hearth line with varying results. The principal objection to this arrangement is the expense of renewing the hearth and baffle blocks every few weeks. The hearth in the type of furnace here illustrated is practically a solid foundation built of common standard-shape firebrick, and as only the top course requires renewal the expense is comparatively slight.

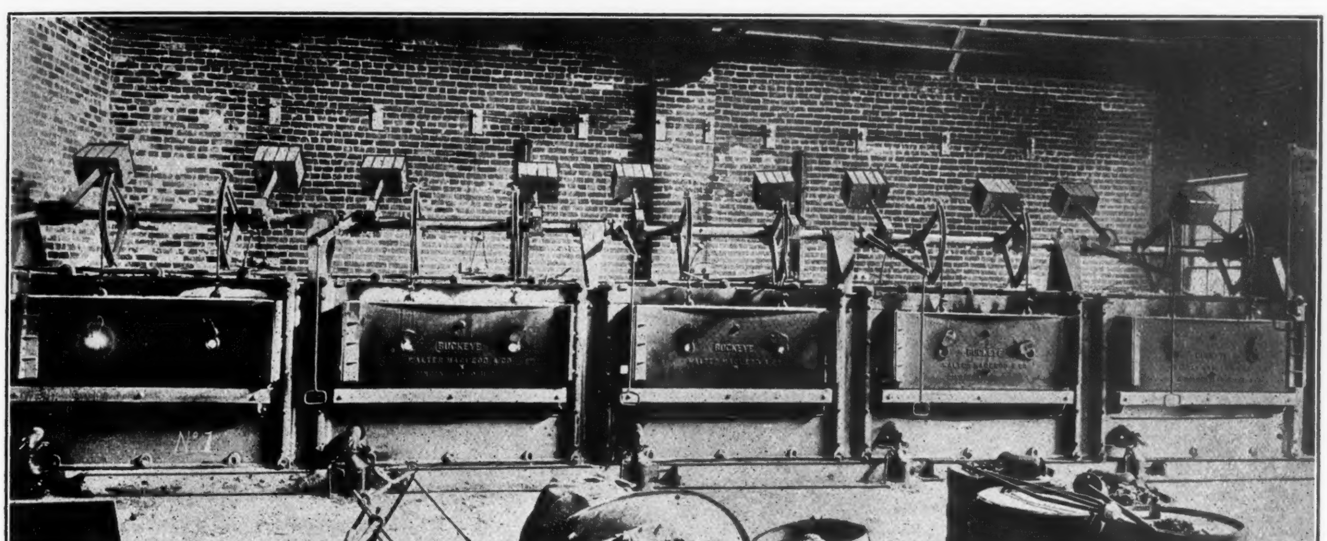


Fig. 1. Battery of Casehardening Furnaces built by Walter Macleod & Co.

The combustion chamber is constructed so that the heat is not bottled up, but is retarded just long enough to permit the gases to fill the chamber and escape with a uniform pressure through the different ports leading into the heating chamber. The covering for these ports is also formed of standard-shape firebrick and can be removed in a few minutes, while the furnace is hot, if necessary. One oil burner is required for each furnace. This is placed in front, parallel with the combustion chamber, and an auxiliary air blast enters the opposite end, thus taking the place of a baffle. The air blast is controlled by a valve located just below the oil burner so that the furnace is conveniently regulated. The oil burners are the company's standard pressure blower type, and, in this instance, operate with an air pressure of 9 ounces.

These furnaces are operated at a temperature of 1560 degrees F., with a variation not exceeding 20 degrees throughout the hearth. This result is made possible by thermo-couples that are inserted in each corner of the furnace. The casehardening furnaces are operated at 1560 degrees F., but this tempera-

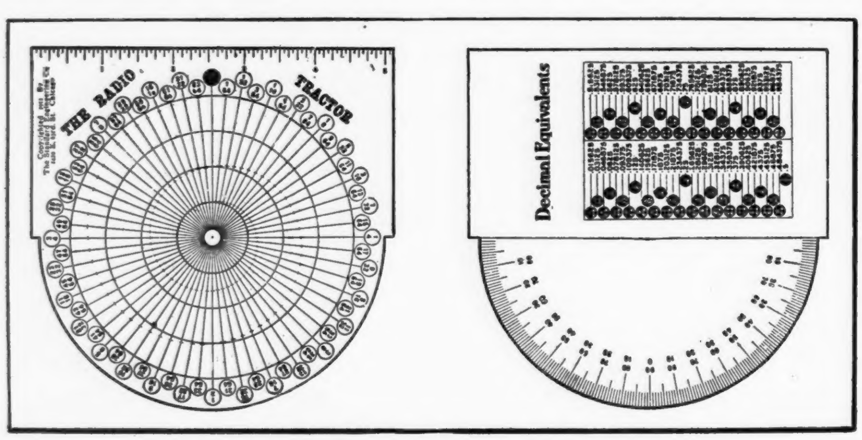
ture decreases 250 degrees during discharging periods; the normal operating temperature, however, is regained in thirty minutes.

The oil and air supply is furnished by an electrically driven unit illustrated in Fig. 3. This consists of a steel fan type blower, directly connected to a 15-horsepower motor. The motor is mounted on a pedestal attached to the side of the blower. A rotary oil pump is also mounted on this pedestal and it is driven from the blower shaft through gearing. This blower has a maximum capacity much in excess of the present requirements, to provide for additional furnaces if necessary. At the present speed of 1460 revolutions per minute, 2830 cubic feet of free air per minute is supplied at a pressure of 9 ounces. The oil pump is fitted with a check valve, relief valve, pressure gage, primer, etc., and draws oil from a central storage supply. A meter is located in the supply line for the furnace and is so arranged that it can be either cut out or used continuously. The capacity of the pump is 9 gallons per minute at 180 revolutions per minute, and the pressure is 40 pounds.

The pyrometer outfit, which is made by the Taylor Instrument Co., consists of a wall-type multiple indicator and base metal thermo-couples, there being one for each chamber. The temperature is indicated periodically. The use of properly calibrated pyrometers in work of this nature is of considerable importance, owing to the necessity of maintaining the temperature accurately.

RADIO-TRACTOR FOR DRAFTSMEN

The "radio-tractor" is an instrument which is intended to save time and eliminate errors when setting dividers to the radii of circles. This instrument has four concentric circles as shown in the view to the left, which have diameters of 1, 2, 3 and 4 inches, respectively. These circles are intersected by sixty-four radial lines representing sixty-fourths of an inch. Each of these radial lines, beginning with the one representing 0 has divisions which, between the 1- and 2-inch circles, advance from the center by 128ths of an inch, thus forming a spiral. Between the 2- and 4-inch circles there is another set of divisions which advance by 64ths of an inch, each division being 1/64 inch farther from the center than the preceding one; consequently, the distance from the center to a division between circles 1 and 2, is one-half the distance between the center and a division on the same radial line between

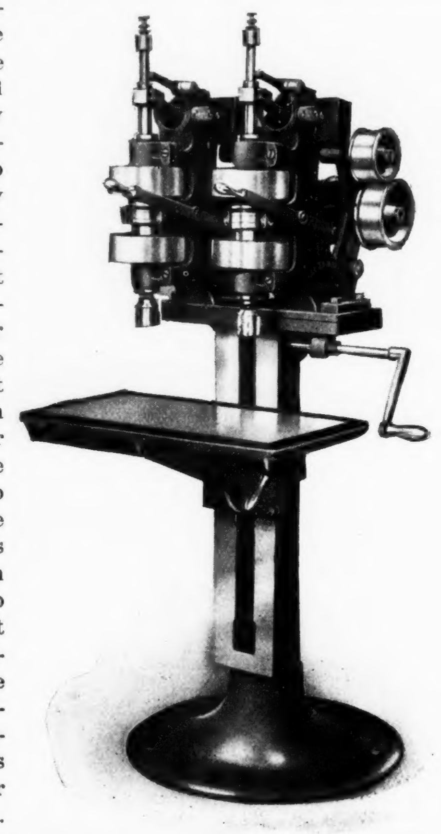


Instrument to facilitate setting Dividers to the Radii of Circles

circles 2 and 4. Therefore, the radius of a circle, say 55/64 in diameter would be the distance from the 1-inch circle to the division inside the 2-inch circle of the radial line marked 55/64, whereas the radius of a circle 1 55/64 would be the distance from the center to the same division. In case the radius of a circle 2 55/64 inch in diameter were wanted, the dividers, instead of being set from the center, would be set by the 1-inch circle on the opposite side of the center, care being taken to keep them on a radial line. In this way the radius of any circle up to 8 inches in diameter may be obtained within 1/64 inch. One edge of the radio-tractor has a half size scale (6 inches = 1 foot) which is very convenient especially for detail drafting. The opposite side of the instrument is a protractor as shown in the view to the right, and there is also a table of decimal equivalents. This instrument is made on durable bristol board and celluloid, and the scales are accurately graduated. It is a product of the Standard Engineering Co., 1410 E. 63rd St., Chicago, Ill.

GARVIN TWO-HEAD AUTOMATIC TAPPING MACHINE

The two-head automatic tapping machine illustrated herewith has recently been added to the standard line of tapping machines manufactured by the Garvin Machine Co., Spring and Varick Sts., New York. This machine, with two heads, practically doubles the capacity of a single-head machine. It operates automatically after the tap is once started, so that the operator can insert another piece for the second spindle to work on while the first hole is being tapped. In this way the two spindles are kept at work continuously, and the output, as compared with a single machine, is increased over fifty per cent. This machine can also be used to advantage for tapping pieces having two holes of different sizes, as the work needs to be handled only once.



Garvin Two-head Automatic Tapping Machine

Each of the spindles is fitted with two friction pulleys driven in opposite directions by a continuous belt connecting with an overhead countershaft. Between these pulleys there is a friction clutch keyed to the spindle, and this clutch is connected by a toggle arrangement with a lever seen at the right of each head. As there is an adjustment that gives any drive desired, an extra safety device to prevent breaking the taps is unnecessary. The tap is started by the hand lever, and it is tripped and reversed automatically at any predetermined point, by an adjustable screw-stop on the upper end of the spindle, which trips a reversing lever at the top of the machine.

The spindles are fitted with a positive drive chuck for holding the taps. The table is adjusted vertically by a screw motion, and it is surrounded by an oil groove as shown. The machine, when using U. S. standard taps, will tap holes varying from 1/16 to 3/8 inch in cast iron, and from 1/16 to 1/4 inch in steel, to the depth of 1½ inch. After a tap is inserted in the work, the machine requires no attention until the hole is finished. It operates satisfactorily at high speed, and is reliable and safe, the breaking of taps being reduced to a minimum.

* * *

One of the most marvelous things is the burning of a jet of hydrogen gas in liquid air. The smoke that arises from the combustion floats off in the air as pure snow. A flame burning brilliantly in the midst of a liquid, with snow given off for smoke !—*Compressed Air Magazine.*

NEW MACHINERY AND TOOLS NOTES

Planer: Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass. Special planer for textile rolls, having a table equipped with multiple, automatic-indexing centers, and twelve planing tools.

Insert Chuck Jaws: Keystone Mfg. Co., Clearfield, Pa. Insert jaws which are placed in an ordinary chuck for holding very small bolts or rods. Three sets of these jaws are made, with capacities varying from 1/8 inch to 11/16 inch.

Vernier for Boring Mill: Cleveland Machine Tool Co., Cleveland, O. This company is attaching a combination vernier scale to its boring mills to facilitate setting the head accurately. By means of the vernier attachment, measurements within 0.001 inch can be taken.

Lathe Dog: West Steel Casting Co., Cleveland, O. Safety lathe dog, the set-screw of which is guarded to avoid the accidents which often result from the lack of such protection. The set-screw can be adjusted by an ordinary wrench. These dogs are of crucible cast steel and are made in standard sizes.

Self-oiling Pulley: Edward Cunningham & Co., Canton, Mass. This pulley is so designed that as it revolves, the oil is thrown outward in the oil chamber by centrifugal force. The oil is then caught by tubes through which it is forced to the oil grooves and along the shaft, finally returning to the oil chamber.

Wheel Guards: Ransom Mfg. Co., Oshkosh, Wis. Cast steel emery wheel guards arranged for exhaust pipe connections. These guards are adjustable so that as the wheel wears, they can be set back to allow the operator to get close to the wheel. The upper plate is removable, thus permitting wheels to be changed without disturbing the main guard.

Lathe: Whitcomb-Blaisdell Machine Tocl Co., Worcester, Mass. Fourteen-inch by six-foot lathe driven by a single pulley and having three spindle speeds obtained by means of sliding gears. The spindle is provided with a brake which acts on the rim of the faceplate and is engaged by the action of the shifter rod. The lathe is surrounded by a large oil pan and is equipped with a pump.

Oil-groove Milling Attachment: National Machine Tool Co., 128 Opera Place, Cincinnati, O. Attachment for milling oil grooves in loose pulleys, etc. Grooves are cut at the rate of approximately 6 inches per minute. By means of an eccentric bushing and four shoes, the tool may be used in ten different diameters of holes. This attachment is used in the drilling machine the same as the keyseating tool made by this company.

Adjustable Triangle: Adjustable Triangle Co., P. O. Box 23, Sta. H., New York. Adjustable 45-degree triangle so arranged that the hypotenuse side can be moved along the base to make any angle with it between 45 and 90 degrees, while at the same time, angles between 0 and 45 degrees are made with the vertical side. Graduations in half degrees on the upper edge of the base, show the position of the adjustable member.

Combination Wrench: Atwood Wrench, Tool & Stamping Co., Conneaut, O. Adjustable wrench designed for pipe and other work. It will take either square or hexagon nuts and does not have to be taken off the nut in advancing. The adjustable jaw has a serrated disk with pinions on each side which engage corresponding racks cut in the handle. The pressure on the handle causes the disk to rotate towards the fixed jaw so that the grip is increased in proportion to the pressure on the handle.

Riddle Oscillator: Hanna Engineering Works, 2059 Elston Ave., Chicago, Ill. Motor-driven oscillator for foundry riddles designed to simulate the action of a molder when screening sand by hand. The action is said to keep the sand in motion continuously which tends to clear the screen meshes to a great extent. The oscillator is furnished with a motor for any of the ordinary electric currents available, and a switch as well as a piece of cable and plug for attaching to a lighting circuit, are included in the equipment.

Operation Recorder: Thwing Instrument Co., Philadelphia, Pa. Instrument for recording the idle and running time of tools. A chart on which the time is carefully recorded is divided into hour spaces, having ten-minute subdivisions. This chart is mounted on a 16-inch drum actuated by a clock. A simple form of contact switch attached to the shifting lever of each machine, through a battery and electro-magnet, closes the circuit as soon as the machine is started, thereby causing the recording pen of the instrument to move from the "idle" to the "operating" position.

Jointer: B. M. Root Co., York, Pa. Jointer designed for pattern shops and other wood-working establishments. The mechanism for adjusting the front table as well as the fence are important features. When the binders of the table base are free, the entire front table mechanism is moved to and from the cutter cylinder, without changing the height of the table, by means of a handwheel at the front. When the table base is fastened, the same handwheel changes the elevation. The cutter cylinder is a steel forging, and is made either square or in the safety round type. Two knives are used with either style. This machine is built in several different sizes.

Gages: W. H. Nichols, Waltham, Mass. External and internal thread gages made in various sizes. Short cylindrical plug gages designed especially for testing holes when grinding. The plugs are mounted on very short handles so that they can be inserted for testing, by running the wheel back a comparatively short distance. Internal gage for testing annular ball races and similar work. It consists of two legs hinged at one end and carrying at the short end a pair of spherical contact points. When using the gage, the jaws are opened until these points make contact with the work, the finished size of which is shown by the contact of the outer ends.

Automatic Screw Machine: B. C. Ames Co., Waltham, Mass. Automatic screw machine designed for producing small high-grade screws, such as are used in watches, small instruments, etc. It makes the screw complete including the slotting operation. Screws as small as 0.017 inch diameter and having 240 threads per inch, are regularly made on this machine, and it is capable of cutting screws as large as 0.070 inch diameter and having 70 threads per inch. It has a wire capacity through the chuck of 0.125 inch. The slotting operation is so timed that it is performed while the succeeding screw is being formed into shape, no extra time being required.

Vertical Surface Grinder: Hemming Bros. Co., New Haven, Conn. Vertical grinder with a capacity for work 12 inches wide and 3 feet long. The spindle, which is provided with ball thrust bearings, is connected through bevel gearing with the horizontal shaft which, in turn, is driven by a four-inch belt. The driving pinion is of raw-hide and meshes with a large bevel gear on the upper end of the spindle. Eight variations of power feed for the table are available, varying from 2 to 10 feet per minute. The table can be adjusted vertically either by hand or power. The platen is entirely surrounded by a pan for catching the cooling water which is fed to the work through the hollow spindle.

Riveter: F. B. Shuster Co., New Haven, Conn. Riveting machine designed for heading both ends of a headless rivet or piece of wire simultaneously. The heading operation is effected by a reciprocating hammer and a rotating hammer held against endwise movement in an anvil carrier bolted to the table. The most important feature is the combination and working of the cylinder and hammer rod with the lowering revolving attachment. The direct and central application of the power, combined with the positive rotary motion of the hammer, causes a regularly applied "breaking-down" action, thus forming perfect heads. The lower revolving fixture may be removed and the machine used for heading one end of a rivet.

Riveters: Hemming Bros. Co., New Haven, Conn. Long-stroke riveter of the elastic rotary-blow type. The force of the blow is controlled by a foot-treadle. Heads of almost any shape can be produced, and the machine will make tight joints or rivet so lightly as to allow the parts to swivel. When heads are to be formed at both ends of a rivet, a lower revolving fixture is supplied. High-speed riveter also of the elastic rotary-blow type. The hammer rod is positively driven by a sprocket and chain, and spinning blows can be delivered at the rate of 6000 per minute. Either a horizontal or vertical table can be attached, and the riveter can also be equipped with a lower revolving fixture for forming two heads simultaneously.

Needle Grooving Machine: Langelier Mfg. Co., Providence, R. I. Special machine for grooving sewing machine needle blades. The one-piece frame of the machine has at the top a slide cross arm, similar to an open side planer, which carries the two cutter heads. A disk, side-acting segment cam feeds each of the cutters to its proper depth. The cutter spindles are driven by a round leather belt and run at a speed of 1050 revolutions per minute. As soon as the grooving operation is completed, the needle is ejected and falls into a trough that leads to a receiving pan. This movement is immediately followed by the feeding of another needle into the work vise. Four needles are grooved per minute, and one operator is able to load the feeding dials for four or five machines.

Continuous Reading Caliper: Blanchard Machine Co., Boston, Mass. Continuous reading caliper, especially designed for the vertical surface grinder built by this company. It gives a continuous measurement while grinding is in progress, thus showing just how much stock must be removed. A hardened steel button rests lightly on the work and connects with a dial gage at the top of the caliper. The zero mark of the dial is first set to agree with the pointer when the button is resting on a size block or a finished piece of the correct thickness. The gage, therefore, shows the amount by which the work differs from the finished size, or the stock that must be removed. As the grinding proceeds, the pointer approaches the zero mark and coincides with it when the finished size is reached. The caliper is held to the machine table and can be swung out of the way when inserting work, without interfering with its adjustment for size.

GEAR-DRIVEN AXLE FOR MOTOR TRUCKS

A rear axle for motor trucks has been designed by the Hindley worm gear department of the Otis Elevator Co., Philadelphia, Pa., to replace the jack-shaft and chain drive

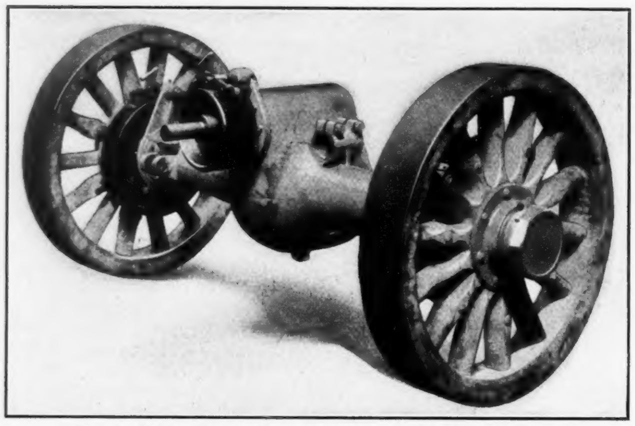


Fig. 1. Motor Truck Axle with Central Spiral Gear Drive

which has been used so extensively on commercial trucks. This new axle, which is shown assembled and in detail in Figs. 1 and 2 has a central spiral gear drive which was adopted because of the impracticability of obtaining the required ratios with the bevel gear drive. The driving gears of the axle illustrated, which is designed for 1½- or 2-ton trucks, have a ratio of either 6 to 1 or 8 2/3 to 1, depending on the capacity of the truck. This change of gear ratio is

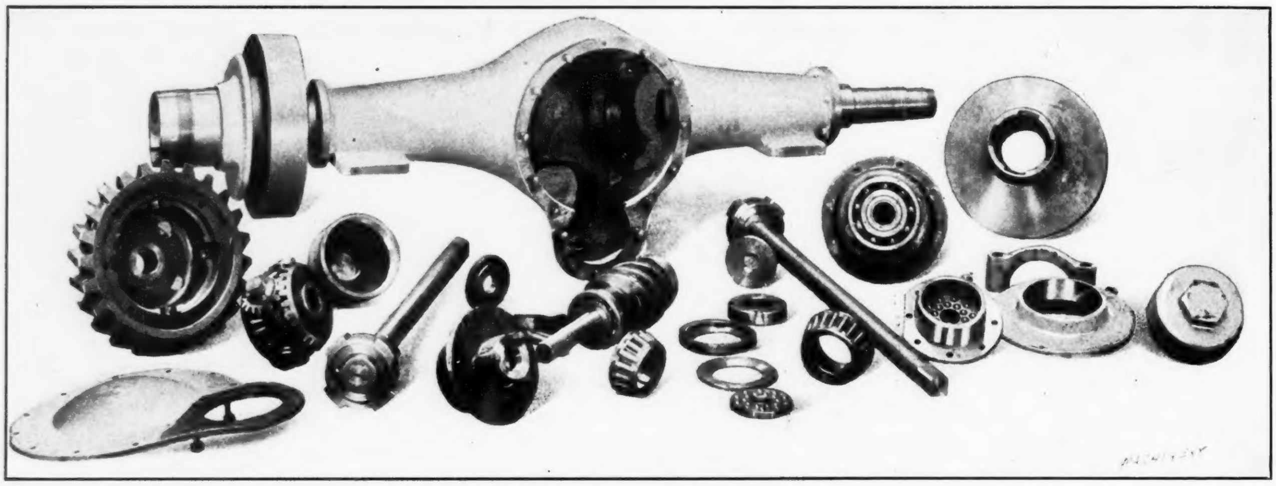


Fig. 2. Various Parts of the Motor Truck Axle

the only difference in the axles used on the 1½- and 2-ton sizes.

The general arrangement of this axle is shown in Figs. 2 and 3. The differential mechanism is of the bevel gear type, and it is contained in a crucible steel casing which is

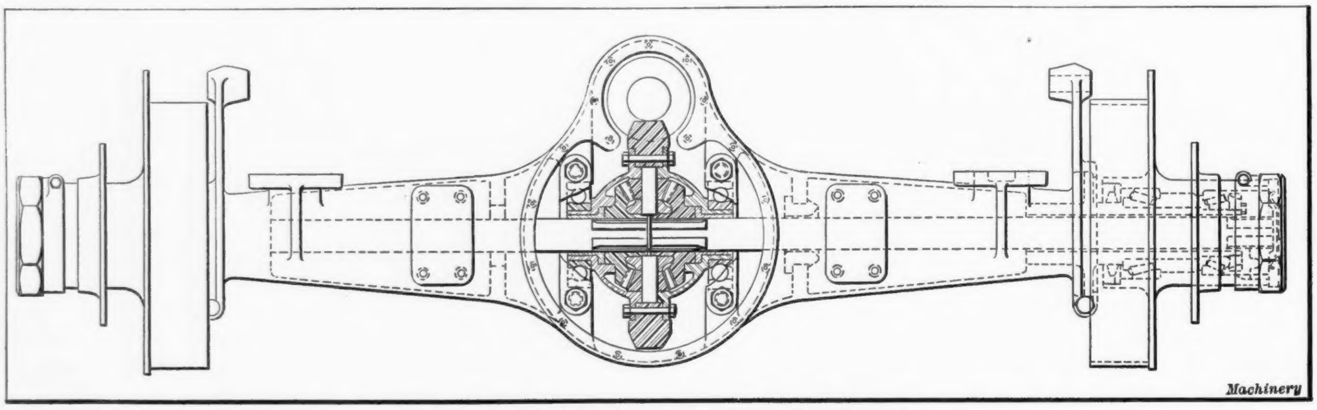


Fig. 3. View showing Differential Gears and Hub Mounting

bolted to the worm-wheel. The gears are made of 0.35 carbon, 3½ nickel steel and are oil tempered. The bevel gears on each side of the differential engage the squared ends of the "live" or driving axles, which have flanged outer ends with projections that lock into the wheel hubs. These axles are also made of 0.35 carbon, 3½ nickel steel and have oil tempered ends. The wheel hubs are of cast steel and are mounted on extra large Standard roller bearings. The outer of these bearings abuts against a collar screwed on the end of the axle casing and the inner bearing rests against a shoulder on the stationary axle sleeve. The wheel itself is firmly riveted between the solid inner hub flange and an outer flange. The end of the hub is closed by a screw cap.

The worm-shaft is mounted in annular ball bearings having ⅝ inch balls, and it is provided with thrust bearings on each side, as shown in Fig. 5. The thrust bearings are equipped with balls of the same diameter and have man-

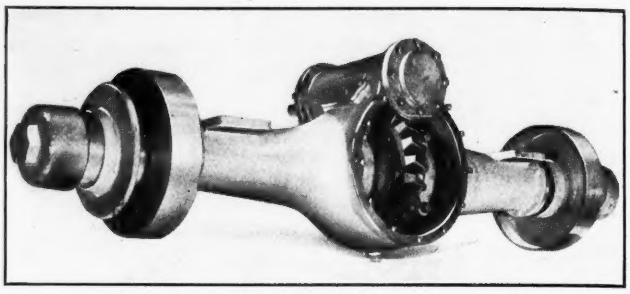


Fig. 4. Rear View of Axle with Cover Removed

ganese-bronze ball retainers. The axle casing is a one-piece steel casting which entirely encloses all the mechanism and protects it from dust. By removing a cover-plate bolted on the rear side of the enlarged central part of the casing, the gears can all be taken out after the bearing caps which hold the differential ball bearings in place have been removed. The worm-gears for the 1½- and 2-ton axle are 12 inches in diameter, and the worm has a diameter of 4½ inches and a pitch of 1½ inch. The worm-wheel is made of 0.35 carbon, 3½ nickel steel, and the worm of 0.90 carbon, special alloy steel. The total weight of this axle is 530 pounds. The 3-ton axle, which is of the same general proportions as the size illustrated, has a 14-inch worm-gear and a 5½-inch worm,

and weighs 600 pounds. The axle is fitted with emergency duplex band brakes on the rear wheels and regular service brakes on the worm-shaft, as shown in Fig. 1.

The point of superiority claimed for the worm-gear drive is that any uneven loading of the truck or uneven road conditions do not affect the alignment of the drive, because the gears are in the center of the axle, thus making a straight-line transmission from the motor to the gear-box. On the

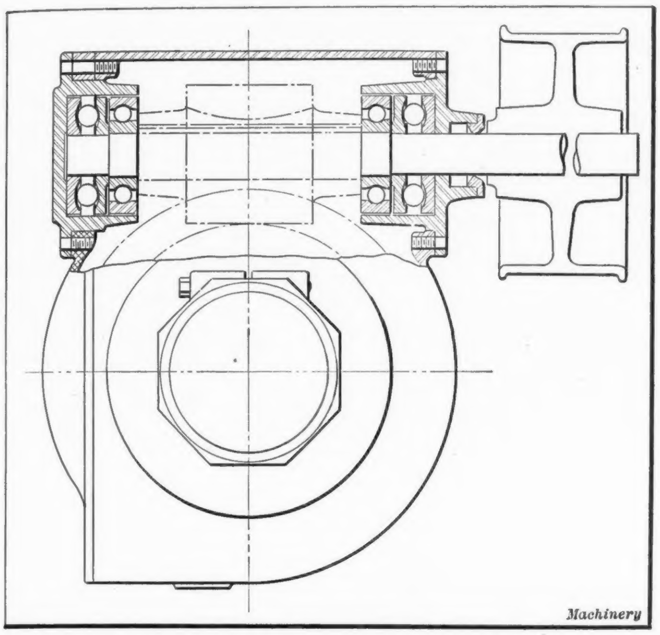


Fig. 5. Sectional View of Worm Radial and Thrust Bearings

other hand, the chain drive, which is on the outside of the frame, is thrown out of line by the unevenness of the road or unbalanced loading. In fact, the chain drive is practically never in alignment when the truck is in motion, except for very short periods, which tends to wear the chains and sprockets irregularly. The chain drive is also exposed to the dust and road grit, whereas the gear-driven axle is entirely enclosed.

* * *

A. S. M. E. MACHINE SHOP PRACTICE COMMITTEE

The American Society of Mechanical Engineers is expanding its activities into many fields of engineering that it has not heretofore specifically recognized. Among these is machine shop practice. The committee recently appointed is as follows: F. E. Rogers (Editor MACHINERY), chairman; L. D. Burlingame (Brown & Sharpe Mfg. Co.); W. L. Clark (Niles-Bement-Pond Co.); W. H. Diefendorf (New Process Raw Hide Co.); A. L. DeLeeuw (Cincinnati Milling Machine Co.); F. L. Eberhardt (Gould & Eberhardt); F. A. Errington; A. A. Fuller (Providence Engineering Works); H. D. Gordon (Jenkins Bros.); H. K. Hathaway (Tabor Mfg. Co.); E. J. Kearney (Kearney & Trecker); Wm. Lodge (Lodge & Shipley Machine Tool Co.).

* * *

THE AMERICAN MACHINIST'S THEATER PARTY

On Wednesday evening, October 11, the *American Machinist* entertained the members of the National Machine Tool Builders' Association and the National Supply and Machinery Dealers' Association and their friends, with a "Trip Around the World" at the New York Hippodrome, where a most enjoyable evening was spent by everybody. The Hippodrome performance this year eclipses all previous efforts. Rapid and startling changes of scenery, marvelous color effects, extraordinary juggling feats and beautiful costumes were only a few of the features of a highly successful entertainment.

* * *

What is claimed to be the world's deepest boring is a hole 7347 feet deep drilled in Upper Silesia. The boring was undertaken to determine the relations of coal beds and was performed by the Prussian government.

THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION CONVENTION

The tenth annual convention of the National Machine Tool Builders' Association was held at the Hotel Astor, New York, Tuesday and Wednesday, October 10 and 11. The meeting was called to order by President F. A. Geier, who made a brief address on trade conditions and the aims of the association. Secretary Charles E. Hildreth spoke in his usual forceful and interesting manner, and read as part of his address a paper by Mr. Charles F. Hilker "The Spirit of Optimism and Its Effect Upon Trade," this being an every-cloud-has-a-silver-lining essay on trade conditions, pointing out the folly of being unduly depressed by a short period of so-called "hard times."

The technical program was devoted to subjects closely relating to shop and factory administrations, consisting of the following papers and discussions:

"Task Work as a Basis of Proper Management," by Henry L. Gantt. (Abstract will be published later.)

"Shop Hygiene as a Factor in Efficiency," by Dr. Winthrop Talbot. (See abstract in this number.)

A description of the physical inspection system and emergency hospital of the Norton Co., Worcester, Mass., by Dr. Clark.

"Standardization of Machine Tools for the Benefit of the User," by L. P. Alford. (See abstract in this number.)

The reading and discussion of papers was followed by an executive session devoted to "heart to heart talks on trade conditions."

The third session in the morning of the second day of the meeting was given up to the following: Lathe, sensitive drilling machine, boring machine, gear cutting machine, grinding machine, hand screw machine, radial drilling machine, planing machine, milling machine, shaping machine, vertical drilling machine and turret lathe committee meetings.

In the afternoon session new members were elected, making thirteen elected to membership at this meeting, and the total membership 166:

E. E. Bartlett Co., South Boston, Mass.
Beaudry & Co., Inc., Boston, Mass.
Cleveland Punch & Shear Works, Cleveland, Ohio.
Ferracute Machine Co. Bridgeton, N. J.
Hilles & Jones Co., Wilmington, Del.
Lenox Machine Co., Marshalltown, Iowa.
National Machinery Co., Tiffin, Ohio.
New Britain Machine Co., New Britain, Conn.
Rowbottom Machine Co., Waterbury, Conn.
Smith & Mills, Cincinnati, Ohio.
Standard Machinery Co., Bowling Green, Ohio.
H. B. Underwood & Co., Philadelphia, Pa.
Watson-Stillman Co., New York City.

A resolution was passed that the annual meetings of the association be three days instead of two, as in the past, and that the semi-annual meeting be two or three days at the option of the executive committee.

The motion was made and passed that the association hire a permanent secretary to devote his whole time to the work of the association. The executive committee was directed to find the desired man and hire him as soon as possible.

The following officers were elected: President, E. P. Bullard, Jr., Bullard Machine Tool Co., Bridgeport, Conn.; vice-president, Fred A. Geier, Cincinnati Milling Machine Co., Cincinnati, Ohio; second vice-president, A. T. Barnes, W. F. & John Barnes Co., Rockford, Ill.; treasurer, A. E. Newton, Prentice Bros. Co., Worcester, Mass.; secretary, Charles E. Hildreth, Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

The next semi-annual or spring meeting will be held in Atlantic City, N. J.

* * *

A manufacturer of shapers alleges that many users of machine tools do not exercise the best judgment in selecting shaper equipment. So much has been said of the advantages of high-speed steel and the need of heavy strong machine tools for economical production that buyers of new equipment are likely to select the heaviest available machines. In the case of shapers it is a mistake to get the heaviest type for a large class of shaper work. Many of the jobs that go into the shaper require light cuts. On such work the heavy shaper is at a disadvantage; it eats up power and is slow in action as compared with the lighter or standard shapers.

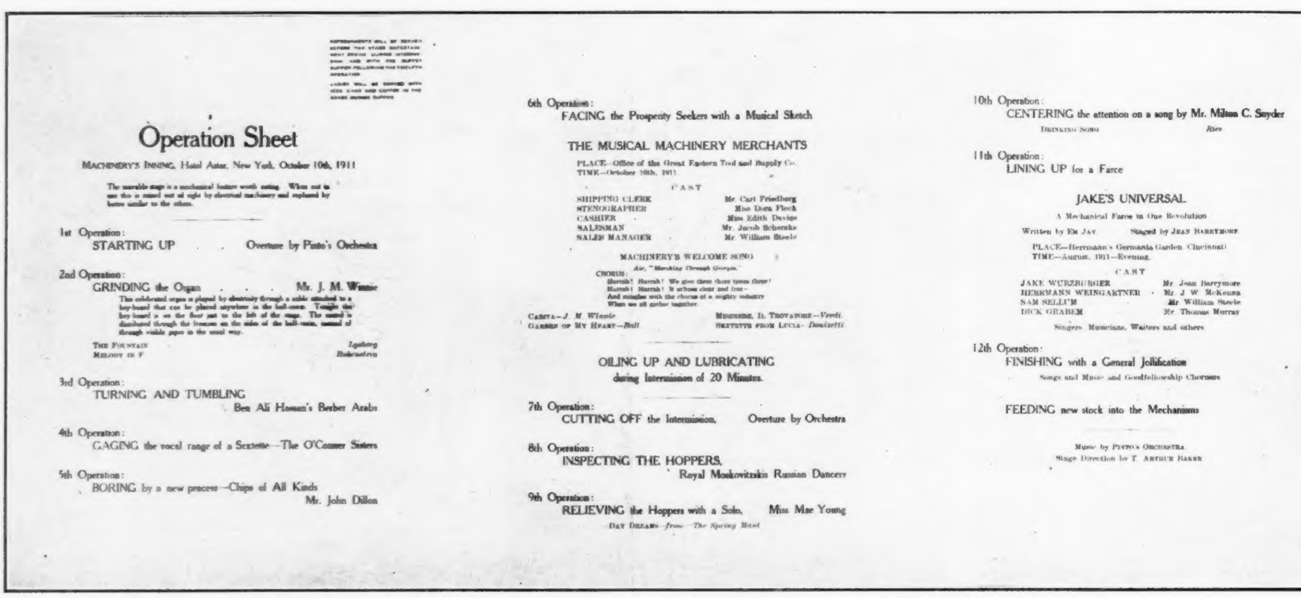
MACHINERY'S NINTH ANNUAL ENTERTAINMENT

For eight years MACHINERY'S outing has been held on the day following the National Machine Tool Builders' convention; but as it was thought this year that the sessions might extend over three days, in order not to interfere with the proposed arrangement the outing was discontinued and an evening entertainment substituted, which was held in the grand ball room of the Hotel Astor, on October 10, and attended by about six hundred and fifty machine tool builders, dealers and others connected with the machinery industry.

The purpose of MACHINERY'S annual entertainment is to promote good fellowship among the principals and executives in the industry; and to facilitate this, instead of having fixed seats in rows there were a hundred or more small tables, at which refreshments were served during the stage performance, and ample space was provided for those present to move about and meet their friends. Supper was served after the close of the stage entertainment. Seats were provided for the ladies in the boxes where they could overlook the stage and the whole assemblage, and where refreshments were served during the evening.

The grand ball room of the Hotel Astor is well adapted to this purpose, as it contains at one end a movable stage operated by electricity, which is replaced by boxes when not in use. MACHINERY'S entertainment consisted of eleven acts, including an original musical sketch and a farce, which contained a number of good-natured hits on well-known people in the machinery industry. The program was gotten up in the form of a Shop Operation Sheet, which is reproduced herewith.

A feature of the evening was the voting of a cup, as an expression of good-will by those present to one of their number. Mr. Amos Whitney was the recipient.


Operation Sheet

MACHINERY'S INNING, Hotel Astor, New York, October 10th, 1911

1st Operation:
STARTING UP . . Overture by Pinto's Orchestra

2nd Operation:
GRINDING the Organ . . . . Mr. J. M. Wiemie

THE FOUNTAIN — Lysberg
MELODY IN F — Rubinstein

3rd Operation:
TURNING AND TUMBLING
Ben Ali Hassan's Berber Arabs

4th Operation:
GAGING the vocal range of a Sextette—The O'Conner Sisters

5th Operation:
BORING by a new process—Chips of All Kinds
Mr. John Dillon

6th Operation:
FACING the Prosperity Seekers with a Musical Sketch

THE MUSICAL MACHINERY MERCHANTS

PLACE—Office of the Great Eastern Tool and Supply Co.
TIME—October 10th, 1911

CAST

SHIPPING CLERK	Mr. Carl Friedberg
STENOGRAPHER	Miss Dora Fleck
CASHIER	Miss Edith Davies
SALESMAN	Mr. Jacob Schoenke
SALES MANAGER	Mr. William Steele

MACHINERY'S WELCOME SONG
Air, "Marching Through Georgia."
CHORUS:
Hurrah! Hurrah! We give them three times three!
Hurrah! Hurrah! It echoes clear and free—
And mingles with the chorus of a mighty industry
When we all gather together.

OILING UP AND LUBRICATING
during Intermission of 20 Minutes.

7th Operation:
CUTTING OFF the Intermission. Overture by Orchestra

8th Operation:
INSPECTING THE HOPPERS.
Royal Moskovitzskis Russian Dancers

9th Operation:
RELIEVING the Hoppers with a Solo. Miss Mae Young
DAY DREAMS from The Spring Maid

10th Operation:
CENTERING the attention on a song by Mr. Milton C. Snyder

11th Operation:
LINING UP for a Farce

JAKE'S UNIVERSAL
A Mechanical Farce in One Revolution
Written by EM JAY   Staged by JEAN BARRYMORE
PLACE—Herrmann's Germania Garden, Cincinnati
TIME—August, 1911—Evening.

CAST

JAKE WURZBURGER	Mr. Jean Barrymore
HERRMANN WEINGARTNER	Mr. J. W. McKenna
SAM SELLUM	Mr. William Steele
DICK GRABEM	Mr. Thomas Murray

Singers, Musicians, Waiters and others

12th Operation:
FINISHING with a General Jollification
Songs and Music and Goodfellowship Choruses

FEEDING new stock into the Mechanisms

Music by PINTO'S ORCHESTRA
Stage Direction by T. ARTHUR BAKER

The Program of MACHINERY'S Ninth Annual Entertainment, made up as a Shop Operation Sheet

* * *

An Eastern textile finishing mill using calendering rolls has trouble with the rolls breaking, despite the fact that they are made with necks nine inches in diameter. The cause was found to be excessive weights placed on the pressure mechanism by the operator. It appears that in England the standard weight required for finishing certain grades of cloth is 200 pounds. The leverage of the machine being 40 to 1, the weight of 200 pounds imposes a load on the rolls of 8000 pounds. The English workmen insisted on using the 200-pound weight on machines built in this country with greatly increased leverage, the leverage being 200 to 1; the result, of course, is a load five times as great as on the English design of machine. Argument did not avail with these workmen trained to do their work in a certain prescribed manner. They would strike rather than use any other but the weights that they were taught should be used for a given operation.

STANDARDIZATION OF MACHINE TOOLS FOR THE BENEFIT OF THE USER*†

Standardization of product is a necessity in manufacturing. It is the starting point in every attempt to produce great quantities of parts cheaply and uniformly, and the advantages are readily recognized. There are similar advantages in the standardization of processes and tools used in manufacturing. The following six important principles should be observed in the standardization of machine tools:

1. Standardize corresponding designations and capacities, and establish a method of power rating.
2. Standardize devices for holding cutting tools.
3. Standardize devices for holding work and fixtures.
4. Standardize operating movements.
5. Standardize parts concerned in the setting up of machines with reference to the permanent shop equipment.
6. Accept the geometric progression as a fundamental requisite in designing feeds and speeds.

Discussion of the First Principle

The first principle aims at a standardization of corresponding machine designations and capacities, and the establishing of a method of power rating. In 1903, action was taken by a number of milling machine manufacturers to establish the maximum feed travels for various sizes of knee-and-column milling machines. For example, the maximum feed travels for a No. 2 universal machine were fixed as follows: Longitudinal, 25 inches; cross, 8 inches; vertical, 18 inches. This was a start toward standardizing designations and capacities. The resulting uniformity is of advantage to the buyer in comparing the various makes of machines designated as Nos. 1, 2, 3, 4, etc. But this is only a beginning.

To illustrate the point, let me ask what is a 14-inch, 6-foot bed engine lathe? To answer my own question, I don't know. From data that have been prepared comparing some of the dimensions of a number of 14-inch, 6-foot bed engine lathes, it is found that the diametral swing over the bed ranges from 14 1/8 to 16 1/8 inches, the swing over the plain carriage from 7 1/2 to 10 3/4 inches, and the maximum distance between centers from 1 foot, 6 inches, to 3 feet 3 inches. From the user's standpoint it is as important to know the diameter that can be swung and turned over the carriage as it is to know the maximum diameter that can be swung over the ways; and the length of the bed is of no more interest than the height of the lathe hand that operates the machine.

Turning to the question of power rating, the user should have some means of distinguishing between the relative capacity for removing metal and mechanical efficiency of ma-

* Abstract of paper by Mr. L. P. Alford, read before the convention of the National Machine Tool Builders' Association, New York, October 10, 1911.

† See MACHINERY, October, 1904, "Standard Nose Threads for Lathe Spindles."

chines of the same dimensional capacity. If he asks for bids on a 20-inch, 10-foot engine lathe, and in one case is quoted $600 and in another $450, he should have some means of knowing that the difference in price represents a difference in metal removing capacity of the tool. Let me call attention to that I propose the establishing of a *method* of rating, not the establishing or standardizing of ratings themselves. We have light-powered and heavy-powered machines; each kind has its field, but there should be some way to differentiate them except by name.

Discussion of the Second Principle

The second principle refers to standardization of devices for holding cutting tools. The small-tool equipment of a shop represents a large investment. The more adaptable this equipment is, the greater the number of hours each small tool can be at work and, therefore, the greater the operating efficiency of the shop. The interchangeability of lathe tools and tool-holders throughout the tool-posts of all lathes of a given size, the interchangeability of milling cutters and their collets among machines of different makes, the interchangeability of drill chucks throughout all the drilling machines of a given department, and so on, represents a real increase in efficiency which is so apparent as to merely need mention to be recognized. To show that this principle has already influenced design, I have but to refer to the taper of the hole in the spindles of milling machines. The Morse taper is extensively used in drilling machine spindles. In ten 14-inch engine lathes investigated, the majority of the tool-post slots were found to be made for ½ by 1¼-inch tools.

Discussion of the Third Principle

The third principle refers to the standardization of devices for holding work and fixtures. The arguments presented in favor of standardizing the devices for holding cutting tools apply here with even greater force, for the devices and fixtures for holding work are individually more expensive than are separate cutting tools. Consider the advantages of chucks interchangeable throughout all of the lathes of a given size in a lathe department, or the advantage of uniform T-slots throughout all kinds of machine tools of relatively the same size. A milling fixture could then be used on any milling machine of a given number, and holding-down bolts could be standardized as regards the sizes of the heads, with the full assurance that they could be used on a milling machine, drilling machine, planer or lathe, as the case may be. In addition to the saving in original investment and the increased flexibility of the equipment, there is an attendant saving in the time required on the part of the workman to find devices that can be used.

To show that something has been done in recognition of this principle, I have but to refer to the table slots of milling machines. On the milling machines investigated, the table slots were uniformly ⅝ inch.

Discussion of the Fourth Principle

The fourth principle refers to the standardization of operating movements. Rapid repetition work depends very largely upon the sense of touch of the operator. Often-repeated movements become, to a great degree, involuntary. It, therefore, follows that a standardization of the operating movements of machine tools will contribute to an operator's speed by making his motions, to a certain extent, involuntary, and permitting him to change from one make of machine to another without any disturbance of the habits that he has formed. On all standard lathes, the same direction of motion of the footstock handle should advance the spindle toward the head. Similarly a definite direction of motion of the handwheel on the carriage should advance the carriage toward the head, and so on.

To show that this principle has been recognized, in the engine lathes investigated the direction of motion of the operating handles was uniform to produce a corresponding movement of the operating parts.

Discussion of the Fifth Principle

The fifth principle sets forth the standardization of parts concerned with the setting up of machines with reference to permanent shop equipment. There are only a few points to be considered here, such as the spread of the bolt holes in the feet of the countershaft hangers, the drop of the shifter rod, and for motor-driven tools, the dimensions of the motor feed pads. I need not dwell upon the advantage to the user in being able to buy a machine that meets his needs from a machine tool builder, and a motor adapted to the machine from an electrical machinery manufacturer, and assemble them himself, knowing that they will fit.

Discussion of the Sixth Principle

The sixth principle refers to an acceptation of the geometric progression as a fundamental requisite in determining relations throughout the chosen ranges for feeds and speeds. I have reason to believe that this principle is very generally recognized, especially among those producing milling machines, but there seems to be a wide difference in the ratios aimed at.

The following lists of features to be considered for standardization are for the four fundamental machines, lathes, planers, drilling machines, and milling machines. This does not imply that standardization cannot be carried on in connection with other machines; on the contrary, the principles laid down are of such a nature that they can and should be applied to all classes of machine tools that are of a fixed type and made by a number of builders. The real work of determining dimensions is a long, tedious task, and cannot be done in a weak-kneed, faltering manner; but personal experience in the work of standardization has taught me that the difficulties in the way are always magnified. The way is easily found if there is a will. What follows is suggestive only.

Engine Lathe Features to be Standardized

Designations and capacities might be linked together by giving three dimensions: First, the swing over the ways; second, the swing over the plain carriage; third, the maximum distance between centers. Thus a 14-inch, 6-foot bed engine lathe would become, say, a 14-inch by 8-inch by 3-foot engine lathe. The maximum swing over the ways should be fixed for each nominal swing; the other dimensions should be exact.

As a suggestion merely, is it necessary to have so many nominal sizes of lathes as are now built and listed? As now arranged, these sizes roughly form an arithmetical progression, having a common difference of two inches. Has anyone considered arranging these sizes in a geometric progression with the direct purpose of reducing their number? If anyone is interested in this, let him start a progression with ten inches and apply the ratio 1.2.

A standard method of power rating might be to give the horsepower of the driving belt for the machine; this power should be figured by means of a given formula with given factors for single, double and triple belts. This same rating could apply whether the machine was belt-driven or motor-driven, because a given type and size of machine is usually built for both methods of applying power. This will permit a careful designer to develop a design that will have a proper relation between power and rigidity. It will also permit the user to compare mechanical efficiencies.

For each nominal size of lathe the following details of designs should be standardized: Diameter, thread, and length of the spindle nose; taper of hole in spindle; diameter of hole through spindle; taper of centers; hole, keyway, face, pitch, and kind of teeth of change gears for the ordinary screw-cutting type; number of threads per inch of lead-screw; size of T-slots in wings of carriage; direction of motion of operating handles; and controlling movements of footstock spindle, carriage, tool-block and compound rest.

Vertical Drilling Machine Features to be Standardized

The features of vertical drilling machines that should be standardized for each nominal size are: Dimensions of table and of finished surface of base; distance from center of spindle to face of column; method of power rating; dimensions of the spindle nose; taper of hole in spindle; number, arrangement, and size of T-slots in the table and base; maximum distance from spindle to table and from spindle to base; and direction of motion of operating handles.

Planer Features to be Standardized

The features to be standardized in connection with planers are: Method of rating; method of stating capacity; number and size of T-slots in the platen; dimensions of reamed holes in platen; and direction of motion of operating handles.

Milling Machine Features to be Standardized

In the planer, drilling machine, shaper and lathe, we have a precedent for a form of designation that of itself indicates capacity. Is there any good reason why the milling machine should not be styled in a similar manner? To illustrate, is not a designation a 25 by 8 by 18-inch universal milling machine better, from the viewpoint of conveying information, than to say a No. 2 universal milling machine?

The features to be standardized in connection with milling machines are: Designation and capacity; method of rating; length and width of working face of table; maximum distance from center of spindle to table; thread on nose of spindle; diameter of nose; taper of hole; width of slot in clutch end; diameter of clutch end; distance from face of column to end of spindle nose; taper of hole in spindle of vertical attachment and index head; diameter of over-arm; distance from center of arm to center of spindle; diameter of bore for outer arbor bearings; width of face of pillar and solid angle of edges; distance face extends above spindle center; number, size and spacing of table slots; diameter and thread of drawn-in bolt; and general position and direction of motion of operating handles.

Inter-size and Inter-class Standardization

Thus far my argument has been directed toward standardization within the general limits of a given size of a given kind of machine. We must also consider the advantages of inter-class standardization. Turning to details of design, a ⅝ inch T-slot should have the same dimensions whether it is in a milling machine table, a drilling machine base, a planer platen, in the wings of an engine-lathe carriage, or in the table of a shaping machine.

If there is an advantage in being able to exchange chucks throughout the individual machines of a lathe department, is there not an added advantage if these same chucks can be used on certain sizes of milling machines? To put it a little more concretely, why should not the spindle noses of 16-inch engine lathes and No. 2 milling machines be identical?

Referring to our fifth principle of standardization, should not the space of the holes in the feet of countershaft hangers for countershafts of approximately the same weight and subjected to the same stresses, be uniform without reference to the machines with which they are used? Again, should not the pads for the feet of a 3-horsepower motor to be applied to a lathe be identical with those for a similar 3-horsepower motor to be used on a milling machine?

As another general point, no screw or other part should be tolerated that has a travel of such a length that a hole must be cut in the floor to accommodate it. Machine users cannot countenance the cutting of holes in shop floors, particularly in buildings where the materials of construction are fire resisting.

* * *

SHOP HYGIENE AS A FACTOR IN EFFICIENCY*

In shop hygiene we deal first with general conditions such as ventilation, heating, cleanliness, lighting, plumbing, lavatories, and dressing rooms, and second, with special conditions such as good drinking water, shop clothing, machinery guards, and medical and surgical treatment.

Whatever measures are adopted for improving the conditions of labor benefit the business. They are undertaken in a spirit of service—not of charity. It is difficult to conceive of any phrase more unconsciously hypocritical than the common expression, "We have done a great deal for our employes," when the fact is rather: "We have done a great deal to make conditions favorable for profitable work." This spirit of service—and it is truly service of the broadest type—should be recognized by a substitution of the words "industrial service" for "industrial welfare work." It is more brief, accurate, and clear.

In investigating shop conditions among even the most progressive concerns, and taking into consideration not only hygiene and sanitation, but those physical conditions, as well, which affect thought, interest, attention and concentration, we are confronted on every hand by evidence of appalling waste. No one can do his work as well in a stuffy, ill-smelling, uncomfortable room, as he can where the air is fresh and pure, and has the right degree of moisture and heat. Working under bad air conditions fosters inattention, inaccuracy, and neglect. The workman is practically forced into these faults through the physical conditions under which he works, yet he is blamed and criticized and frequently loses his job because of them.

If it is worth while to employ a mill-wright especially to attend to the belts and the transmission of power in general, it is certainly worth while in every shop to appoint a competent and interested man to look after the ventilation, and the temperature and moisture of the air, and also the illumination and cleanliness of the plant. In many shops with the best methods of ventilation, installed at large expense, no one is appointed to see that this expensive apparatus is given the attention necessary to insure comfort to the working force, or else, if this work is in the hands of any particular man, it is likely to be a man selected for the job because he is cheap. This is true even of the better class of plants, and poor ventilation is as frequent in the executive offices as in the work shop.

The relation of temperature to moisture, and the air movement in a room are important factors in the provision of comfortable working conditions. Satisfactory conditions are not determined entirely by the number of cubic feet of fresh air per second brought into the establishment. As a result of careful study made by Mr. Royce W. Gilbert, it may be said, roughly, that the maximum of comfort due to air conditions is a temperature of from 65 to 70 degrees F., accompanied by 50 to 60 per cent humidity, and a draft of air at the rate of from two to five feet per minute.

Methods of cleaning which do not simply move the dirt from one place to another should be adopted. The corn broom, and dry dusters are dust *movers*, not dust *removers*. Dry sweeping is a germ distributor, and should never be permitted in a room where there are human beings. In one shop the employes were kept idle for fifteen minutes before twelve o'clock on Saturday (in order not to have them leave before noon) and during that fifteen minutes vigorous sweeping was going on, filling the air with germ-laden dust carrying colds, bronchitis, pneumonia, diptheria, and consumption, and infecting the workers with less power of resistance.

It cannot be considered good shop practice to be without accommodations where the workers can keep shop clothing or change and dry their wet foot-gear. Due to investigations undertaken during the last six months, it has been found that a large percentage of sickness is caused through the workers' taking cold by being obliged to work in rain-soaked garments, or by going out-doors in clothing that they have worn all day in the shop. This is not only true of women workers, but also of men.

Under the general head of sanitation and hygiene naturally would come the consideration of dressing-rooms, lavatories, and plumbing. All up-to-date shops have individual lockers for the workmen. The preferable form is the locker closed on the sides with solid partitions, but with perforated metal doors throughout the whole length of the front for inspection and cleanliness. The trend in the best organized shops is toward individual wash-basins; they increase the self-respect of the workmen and help to attract a better class of labor.

* * *

The situation in the shipbuilding industry has recently undergone a marked and gratifying change for the better. The great shipyards like the Newport News Ship Building & Dry Dock Co., Newport News, Va., the Maryland Steel Co., Sparrows Point, Md., the New York Ship Building Co., Camden, N. J., and others have so much work on hand that they can scarcely lay another keel for from twelve to eighteen months, and it looks as if prosperity had come to stay.

* Extracts from a paper by Dr. Winthrop Talbot, read before the convention of the National Machine Tool Builders' Association, New York, October 10, 1911.

THE USE OF MAGNALIUM IN AERONAUTIC MOTORS*

The heaviest part of a flying machine is the power plant, and, therefore, the efforts made toward reducing its weight have been mainly centered upon reducing the weight of the motor. Aluminum or aluminum alloys have been used wherever it was possible to substitute these alloys for heavier metals, such as iron. The latest method of reducing the weight has been by the successful use of magnalium, an aluminum alloy, for the cylinders. The attempt to use aluminum or aluminum alloys for gasoline engine cylinders is not new, but for years it has been unsuccessful. It was not possible to get castings of aluminum that were dense enough to hold the pressure immediately following the explosion in the cylinder, because castings of aluminum are of a porous nature, although the pores may be very small. An aluminum casting will crystallize under constant pounding or vibration, and in a short time become brittle. Therefore, if such castings were used in a cylinder, the constant blows caused by the explosions would soon make the cylinder very brittle, and it would finally crack. Another objection to aluminum was that the metal would not wear, and for many years cast iron or steel seemed to be the only metal that could be successfully used in cylinders.

Attempts have been made to cast cylinders of aluminum, using a cast-iron sleeve to take the wear and to hold the pressure of the gas. This in some instances proved unsuccessful because of the difference of expansion between the two metals. The only method of casting an aluminum cylinder with a cast-iron liner successfully seems to be to heat the liner with a torch or in a furnace, and then to pour the aluminum rather cold; pouring aluminum cold, however, was never calculated to bring about the best results in the castings.

Within the last year magnalium, which is manufactured in Germany, and which is composed principally of aluminum alloyed with a small proportion of magnesium, has been successfully used for aeroplane engine cylinders. The metal is not only lighter than aluminum castings, but even lighter than pure aluminum, because it contains magnesium. The metal weighs about one-third of what iron weighs. A magnalium cylinder with an iron piston and iron piston rings seems to give better wear than an iron cylinder under the same conditions. After a few hours running, the bore of a magnalium cylinder seems to take on a very high mirror polish, which is similar in appearance to the polish of a high percentage tin alloy bearing metal, which has had a steel shaft running in it for a long time.

An interesting fact in connection with the use of this metal for cylinders is that there are instances on record where a cylinder was not reamed carefully enough, but the engine was assembled and run, and instead of the cylinder being scored, it was the piston and the piston rings which were scored so badly that they had to be replaced after the inside of the cylinder had been burnished. The burnishing of the inside of the cylinder seems to be a very desirable feature in connection with the use of this metal.

Castings of magnalium seem to be much denser than those of any other aluminum alloy and they hold the pressure produced in the cylinder without giving trouble. The metal is much tougher than aluminum. Sometimes in the foundry a core will shift in a casting, and it becomes necessary to break up and remelt the casting. In the case of other aluminum alloys this is very easily done, because one or two blows with the sledge hammer will readily demolish the casting. With magnalium, however, it has been found necessary, in order to break up a casting, to heat it several hundred degrees, and it requires from ten to fifty times the amount of sledging to break it up.

The metal is about 12½ per cent lighter than castings of aluminum, containing 93 per cent aluminum and 7 per cent copper. The metal is also considerably stronger than castings of this alloy. Another interesting fact in connection with the use of this metal in cylinders is that the thermal conductivity of magnalium is from seven to eight times that of iron. This simplifies the cooling problem. On account of the toughness and strength of the metal, it is being used not only for cylinders, but also for crank-cases, water pumps, intake manifolds, and various other parts.

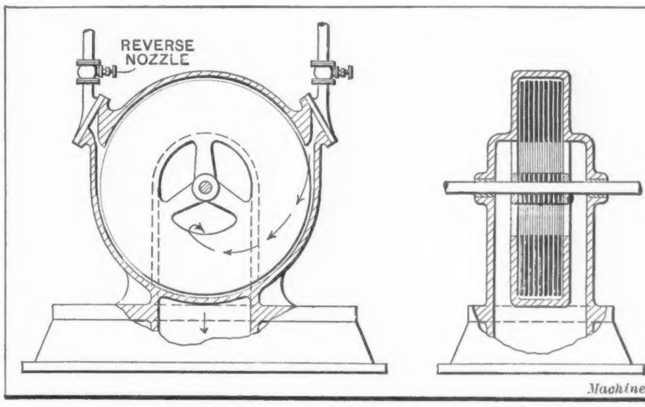
The metal can be given and maintains a high polish, and cylinders of this metal, when finished on the outside, give a motor a very handsome appearance; but most important of all, the use of this metal for cylinders makes a considerable reduction in the weight of the average aeroplane engine, because, as a general rule, the weight of the cylinders is a large proportion of the weight of the motor.

*See MACHINERY, April, 1911, engineering edition, "Light-weight Alloys for Aerial Engines and Aeroplanes"; January, 1911, engineering edition, "Light Alloys for Airship Construction"; July, 1908, engineering edition, "Magnalium."

* * *

THE TESLA STEAM TURBINE

Experiments with a novel design of steam turbine have been made by Mr. Nikola Tesla, who is well known in the electrical field on account of the part he has played in the developments in connection with the rotating magnetic field and other alternating current subjects. A diagrammatical section of the Tesla steam turbine is shown in the accompanying illustration. The steam is expanded in a nozzle and the heat energy is thus converted into kinetic energy. The rotor of the steam turbine simply consists of a number of thin flat disks, the inlet for the steam being at the outer periphery of these disks and the outlet being at their center, as indicated. The high velocity steam escaping from the nozzle is caused to impinge tangentially on the edges of the disks,



Diagrammatical Sections of the Tesla Steam Turbine

and in order to escape it must find a path from the periphery of the disks to the central outlet. The velocity energy of the steam produces a rotary motion of the disks, due to molecular drag on the surface, and hence the path of the steam from the outside to the inside of the disks will be a spiral one. Expressing the matter in popular terms, we may say that the action is due simply to the friction of the steam against the sides of the disks as the steam moves from the outside periphery to the center along a spiral path.

The arrangement shown in the illustration permits of easy and convenient reversal, as it is only necessary to provide a duplicate nozzle discharging against the opposite side of the disks as indicated. When the machine is at rest, or is running slowly, as in starting, the steam takes the shortest path from nozzle to exhaust, and thus develops a comparatively large torque. As the machine speeds up, the difference in velocity between the steam and the disks decreases, and the centrifugal force tends to lengthen the spiral path of the steam, so that a given amount of steam may make several revolutions with the disks before finally passing out through the exhaust opening.

A turbine of this type has been tested at the Waterside Station of the New York Edison Co. The rotor of the tested turbine has 25 disks, each 18 inches in diameter. The assembled turbine occupies a floor space of 20 by 35 inches and is about 5 feet high, completely installed. With steam at 125 pounds gage pressure per square inch exhausting into the atmosphere, 200 horsepower was developed with a speed of 9000 R. P. M. The steam consumption was 38 pounds per horsepower-hour. The weight of the turbine is 400 pounds, giving a unit weight of only 2 pounds per horsepower. While the steam consumption at present is rather high, Mr. Tesla

believes that with moderate superheat and a degree of vacuum the same as that ordinarily used in a turbine plant, the steam consumption can be reduced materially.

The principle employed is not limited to steam turbines. It can be applied as well to a type of centrifugal pump, having a series of smooth flat disks revolving in a casing, these disks having no vanes or other impelling projections. The motion of the water is produced simply by the friction or molecular adhesion between the disks and the fluid. In this case the fluid is, of course, taken in at the center of the disks and forced along a spiral path to the outside periphery.

* * *

PRIME FACTORS OF NUMBERS

To determine the prime factors of a given number, if it have any other than itself and unity, seems to have been one of the first problems to attract the attention of mathematicians. From the days of Eratosthenes, the inventor of factor tables, to the present time the interest in the problem has never flagged. In spite of the fact that in the nature of things a complete solution is hardly to be expected, scarcely a year passes in which some new device for finding the factors of a given number is not published. The net result of all these centuries of effort is perhaps insignificant. The examination of a number beyond the reach of tables, even with the most efficient methods, is still a tedious and difficult task. The list of primes above 10,000,000 with the exception of a few of special form, must be considered as practically unknown. The highest prime so far identified is $2^{61}-1$, a number containing nineteen digits.—*Extract from Preface of Factor Table for the First 10,000,000 by D. N. Lehmer, Publication, No. 105 of the Carnegie Institution of Washington*, 1909.

* * *

TRAINING TECHNICAL GRADUATES AT THE WESTINGHOUSE WORKS

In a paper presented before the annual convention of the Society for the Promotion of Engineering Education, at Pittsburg, Pa., June, 1911, by Messrs. C. F. Scott and C. R. Dooley, the method used by the Westinghouse Electric & Mfg. Co., for adapting technical graduates to the industries, was described. The two-year special apprentice course for technical graduates which was adopted by the company several years ago has been modified to a certain extent, principally by supplementing the factory and testing-room experience with actual class-room instruction, and by specializing the training during the latter part of the course so as to adapt it to the particular work which the young engineer expects to follow later.

For the last ten or fifteen years the Westinghouse Co. has received annually several hundred technical graduates who have been regularly employed in the factories. During this course the young men were formerly transferred from department to department, gaining a general knowledge of the construction in use in electrical apparatus and of business methods. Little was done, however, in the way of systematic instruction bearing directly on factory and office work. It has been found, however, that for several reasons a modification of this plan is a step towards more thorough training. One of these reasons is that electrical apparatus is at the present time of so many kinds and so specialized that ordinary shop work will not give the student sufficient instruction. His point of view is apt to be that of the workman who only knows the construction of the coil he winds or the arc lamp he assembles, but who does not appreciate why the apparatus is made as it is in order to be reliable, efficient and durable. The time available in the various departments in the factory is too short to enable the student to cover the whole ground thoroughly and, therefore, is likely to be superficial, if too many departments are included.

For these reasons, the new special apprentice course includes two periods, of which the first is given over to general training in the factory confined to a few departments, and the second is a special course fitting the men for the engineering, sales or other departments. The work is supplemented by class-room instruction during working hours for about four hours a week. Six hours per week outside of the regular working hours are also required to be devoted to assigned reading or study, or technical meetings. The technical instruction supplements directly the work of the factory. Men who are working on a particular kind of apparatus have an instruction period devoted to it each week. Books or appropriate articles on the subject are assigned for reading, and a list of questions is given to the students to be answered.

The experience during this first period places both the young man and the company in a position to make an intelligent selection of the department for which he is best fitted, and in the second period he is trained especially for the engineering, sales or other departments. That these methods of training are a valuable addition to the regular college work is evident, and it is to be regretted that it is possible only for very large concerns to thus systematically educate men for positions in the mechanical and electrical engineering field.

* * *

PERSONALS

George S. Delaney, general superintendent of the Stevens-Duryea Co., Chicopee Falls, Mass., has resigned his position after being six years in the company's employ.

Theodore Brown, for the past ten years mechanical engineer with the Richardson Mfg. Co., Worcester, Mass., has resigned to become shop manager of the Harvesting Machinery Co., East Moline, Ill.

Erik Oberg, associate editor of MACHINERY, read a paper on "The Prevention of Accidents in the Industries," before the American Society of Swedish Engineers, Brooklyn, N. Y., October 21.

J. Cecil Nuckols, for the past seven years advertising manager of the S. Obermayer Co., Cincinnati, Ohio, has resigned to become advertising and sales manager of the Otis Hidden Co., Louisville, Ky.

Halsted Little, for many years associated with the sales department of Manning, Maxwell & Moore, Inc., has been appointed Eastern sales agent for the Detroit Twist Drill Co., with offices at 30 Church St., Room 604, New York.

Prof. H. B. Smith, professor of electrical engineering at the Worcester Polytechnic Institute, has been granted a two-years leave of absence for study and travel. He sailed in September for Europe where he expects to spend the time.

F. J. McGrail, formerly of the H. R. Worthington Co., Harrison, N. J., and for the past two and one-half years foundry superintendent of the Struthers-Wells Co., Warren, Pa., has resigned to become foundry superintendent for the Erie Foundry Co., Erie, Pa.

C. R. Vincent, for several years president of the Ball & Wood Co., Elizabethport, N. J., has assumed the managership of the monel metal department of the Ruggles-Coles Engineering Co., 50 Church St., New York, general agents for the Bayonne Casting Co.

Einar Morin, well-known to the readers of MACHINERY as the author of the series of articles "Jigs and Fixtures" published in MACHINERY some years ago, has been made superintendent of the works of Vagn & Maskinfabriks Aktiebolaget, Falun, Sweden, builders of locomotives and railway cars.

Claude E. Cox, factory manager of the H. E. Wilcox Motor Car Co., Minneapolis, Minn., has resigned to become resident manager of the engineering laboratories of the General Electric Co., Detroit, Mich., which are being conducted by Arthur D. Little, Inc., Boston, Mass. Mr. Cox is the designer of the "Overland" and "Interstate" cars, and brings to his new connection an intimate knowledge of motor car construction.

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OBITUARIES

Charles Koegel, senior member of Charles Koegel & Son, Holyoke, Mass., manufacturer of paper machinery, died at his home in Holyoke recently.

Robert Mather, chairman of the board of directors of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., died of peritonitis at his home in New York, October 24, aged fifty-two years.

John Souther died at his home in Newton, Mass., September 12. Mr. Souther established the Globe Locomotive Works in 1831 in South Boston. During the Civil War he built the machinery and iron work for sixteen war vessels. He was the inventor of the automatic sprinkler for fire protection and invented machinery for making ice. He retired from active work in 1881.

C. Franklin Weiler, secretary and treasurer of the Cortland Corundum Wheel Co., Cortland, N. Y., died at Saranac Lake, Sunday, September 17, of tuberculosis, after an illness of about two years, aged thirty-nine years. Mr. Weiler became associated with the company at its organization in March,

1902, and by close attention to the growing needs of the company gradually worked his way up until elected to the position he held at his death. The funeral services were held at his late home in Cortland on Friday, September 22.

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COMING EVENTS

November 2-4.—Annual meeting of the International Society for the Promotion of Industrial Education, Cincinnati, Ohio. R. T. Davis, secretary, 18 W. 44th St., New York.

December 5-8. Annual meeting of the American Society of Mechanical Engineers in New York. Calvin W. Rice, secretary, 29 West 39th St.

December 5-8.—Annual meeting of the National Gas and Gasoline Engine Trades Association at the Hotel Hollenden, Cleveland, Ohio. An exhibit of accessories will be an important feature of the convention. Albert Stritmatter, secretary, 224 E. Seventh St., Cincinnati, Ohio.

January 18-20, 1912.—Annual meeting of the Society of Automobile Engineers in New York. Coker F. Clarkson, general manager, 1451 Broadway, New York.

September 2-7, 1912.—Sixth Congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. One of the important functions of this association is to establish standard specifications for materials used in manufacture and construction. The cooperation of engineers and others who are engaged in the purchase and use of the raw materials of the trades, is requested. The annual dues are $2, with no initiation fee. Mr. H. F. J. Porter, secretary, 1 Madison Ave., New York.

SOCIETIES AND COLLEGES

American Museum of Safety, 29 W. 39th St., New York. Safety leaflet No. 1 on presses and punches, illustrating safety devices for preventing the maiming of operators.

American Railway Tool Foremen's Association. Official proceedings of the third annual convention, Chicago, Ill., July 11-13, 1911. Mr. H. Bray, secretary and treasurer, N. Y., N. H. & H. R. R., New Haven, Conn.

University of Pittsburg, Pittsburg, Pa., through its department of industrial research, under the direction of Prof. Robert Kennedy Duncan, is undertaking a scientific study of the problem of smoke prevention in all its various phases. The study will extend over a period of at least two years and as much longer as is deemed necessary to accomplish the end in view. Because of the great importance of the subject and the wide field to be covered, Prof. Duncan is desirous of being put in touch with people who are working along these lines.

Williamson Free School of Mechanical Trades, Williamson School Post Office, Delaware Co., Pa. Bulletin No. 9 containing standing of the classes of 1910 and 1911. The class of 1910, consisting of fifty-one members, was graduated on March 26, and within six months after graduation the members were earning an average of $16.60 per week. Eighteen months after graduation the general average was $18.05. The class of 1911 consisted of sixty-five members, graduated on March 25. Six months after graduation the average was $15.57, notwithstanding the depression of business.

American Museum of Safety, 29 W. 39th St., New York. Catalogue of exhibits in the museum. These comprise full-size apparatus models and working models of a great variety of apparatus; photographs, drawings and blueprints of safety devices; library reports and publications. The list of exhibitors comprises one hundred and sixty-one well-known concerns. The museum is non-commercial, and is not a show-room for patented safety devices. It has a special charter from the state of New York. It is the aim of the promoters of the museum to show only those means and methods of accident prevention that are sanctioned by practical use and the advice of competent engineers.

Wentworth Institute, Boston, Mass. Catalogue 1911-12. This new institution for industrial education was founded by Arioch Wentworth "for the purpose of furnishing education in the mechanical arts." The catalogue is illustrated with views showing the shop equipment, and students at work. Day classes are provided for carpentry and building, patternmaking, machine work, foundry practice, electric wiring, plumbing, machine construction and tool design, electrical construction and operation; and evening classes in carpentry and building, patternmaking, machine work, tool-making, foundry practice, electric wiring, and plumbing. Evening technical courses are: practical mathematics, mechanical drawing, machine design practical mechanics, strength and properties of materials, the steam engine and the operation of power plants, applied electricity, and electrical machinery.

Lewis Institute, Chicago, Ill., has just issued a schedule of continuation courses which will be given evenings and Saturdays beginning October 9, 1911. The schedule includes engineering, chemistry, physics, mathematics, drawing, languages, and household arts. The courses are arranged so that they can be taken independently or in connection with regular college work or in series to form a logical development of the subject. In general, the courses are designed to afford those who are employed an opportunity to continue their vocational studies. Of the total enrollment of 3200 during the past season, over 1800 were enrolled in the continuation classes. The engineering series includes: Engineering principles; electrical measurements; direct-current machinery; rotary convertors in sub-station work; alternating-current principles; transformers and transmission lines; alternating-current motors, and generators; steam engine testing; internal combustion engine; structural steel design; concrete reinforced. The mechanic arts series includes: Mechanical and architectural drawing; machinery drawing; machine design; lathe and milling machine work; tool and die making; pattern making; foundry and forge work.

NEW BOOKS AND PAMPHLETS

Tests of Nickel-Steel Riveted Joints. By Arthur N. Talbot and Herbert F. Moore. 53 pages, 6 by 9 inches. 22 illustrations and diagrams. Published by the University of Illinois, Urbana, Ill., as Bulletin No. 49.

This bulletin gives the results of tests for slip and strength of 106 nickel-steel riveted joints and 70 chrome-nickel-steel joints. The tests of nickel-steel joints were undertaken at the request of the board of engineers of the Quebec Bridge, and those of chrome-nickel-steel joints at the request of the Pennsylvania Steel Co. The tests were made in tension and in alternated tension and compression. It was found that noticeable slip of rivet occurred at loads within the ordinary working stress and that the slip was much greater under loads alternated in direction than under tests in one direction only. The slip of joints seemed to depend upon the workmanship rather than on the material. The nickel-steel and the chrome-nickel-steel joints showed higher ultimate strength and much higher resistance to bending of the rivets than the joints of ordinary structural steel. The conclusion to be drawn seemed to be that in rivet joints designed on the basis of ultimate strength, the use of rivets and plates of nickel-steel may be of advantage, but that in riveted joints designed on the basis of frictional hold for rivets against slip, there is little advantage in using special rivets of great strength.

CATALOGUES AND CIRCULARS

Gisholt Machine Co., Madison, Wis. Leaflet illustrating installations of boring mills.

Gilbert & Barker Mfg. Co., Springfield, Mass. Folder illustrating a Gilbert & Barker oil fuel furnace.

D. M. Watkins & Co., 95 Pine St., Providence, R. I. Card illustrating Watkin's automatic safety attachment for drop hammers.

Green Fuel Economizer Co., Matteawan, N. Y. Samples of Green's temperature pendants for determining the temperature of flue gases.

Westinghouse Electric & Mfg. Co., Pittsburg, Pa. Leaflet No. 2371 treats of Type Q engine-driven direct-current interpole generators manufactured by the company.

Lutter & Gies Co., Milwaukee, Wis. Circular of Milwaukee wet tool grinder with motor drive. The water in this grinder is applied on the wheel when grinding, by an air jet.

American Foundry Co., Leipsic, Ohio. Circular of the "Buckeye" electric breast drill for either alternating current or direct current. These drills are reversible and can be used for tapping.

General Electric Co., Schenectady, N. Y. Bulletin No. 4873 on "Control Apparatus for Steel Mills," describing automatic compensators, contactors, master controllers, rheostatic controllers, etc.

Joseph Dixon Crucible Co., Jersey City, N. J. Card giving the melting points of metals and their specific gravities. The melting points are given in both the Centigrade and Fahrenheit scales.

Erie Forge Co., Erie, Pa. Photograph of a metal scrap yard, the purpose of which is to show the character of the scrap used in the company's manufacture of open-hearth steel, which is especially low in phosphorus and sulphur.

Garvin Machine Co., Spring & Varick Sts., New York. Circulars of the Garvin plain milling machine No. 2-A; vertical milling machine No. 22; rapid screw-slotting machine; plain milling machines Nos. 13 and 13½, and cutter and surface grinders.

Richardson-Phenix Co., Milwaukee, Wis. Treatise on the Richardson system of lubrication illustrating applications to Corliss engines and gas engines, and showing the filters, oil pump, sight feed oilers, and other apparatus forming parts of the system.

Makutchan Roller Bearing Co., Hobart, Ind. Circular of the Makutchan roller bearings for lineshafts, etc. Makutchan bearings are provided with double tapered rollers having a groove in the center which engages a rib in the bearing that keeps the rollers in alignment.

Standard Roller Bearing Co., Philadelphia, Pa. Bulletin No. 26 on the application of roller bearings to car journals, illustrated with drawings and halftones. The subject of roller bearings for railway cars is of much general interest, and engineers will find the bulletin of value.

Westinghouse Electric & Mfg. Co., Pittsburg, Pa. Folder No. 4186 illustrating and describing an auxiliary line switch for use on trolley cars equipped with ordinary drum-type controllers. The auxiliary line switch is electro-pneumatically operated, and is mounted underneath the car.

American Swiss File & Tool Co., 24 John St., New York. Interesting pamphlet illustrated in colors entitled: "The True Story of an Industrial Soldier, by a Graduate of the College of Hardnox." This original and interesting piece of literature will well repay perusal. Sent free upon request.

William A. Peck, 141-145 Brewery St., New Haven, Conn. Catalogue of mechanics' tools comprising nail sets, prick punches, wood scrapers, combination callipers and dividers, tap and reamer wrench, screw driver bits, center finder, machinists' jack screw, plumb-bobs, "Midget" screwdrivers, etc.

W. A. Whitney Mfg. Co., Rockford, Ill. Postcard illustrating the Whitney portable hand-punch made in two sizes. The No. 1 punch has a capacity to punch a 9/16-inch hole through a 1/4-inch boiler plate, and weighs 21 pounds. The No. 2 punch has a capacity for punching 5/16-inch holes through 1/4-inch iron and weighs 12 pounds.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalogue of "Brownhoist" locomotive cranes illustrating many applications of the 20-, 15-, and 10-ton types with various equipments of handling devices including grab buckets, lifting magnets, etc. A three-ton locomotive crane is also illustrated, and electric work car cranes of five tons capacity.

National Tube Co., Frick Bldg., Pittsburg, Pa. Bulletin No. 6 on pipe threading dies illustrating the differences between pipe properly and improperly threaded, and showing how pipe dies should be made and set. Information is given on lip, chip space, clearance, lead, number of chasers, oil, etc.; sent on request to all interested in pipe threading.

McCrosky Reamer Co., Meadville, Pa. Catalogue of adjustable reamers, chucks and collets, expanding mandrels, and universal lamp brackets, treating specifically hand reamers, machine reamers, shell reamers, cylinder reamers, "Wizard" quick-change chucks and collets, turret tap holder, taps, "Wizard" variable-speed reversing tapping attachment, expanding mandrels, etc.

Adams-Bagnall Electric Co., Cleveland, Ohio. Catalogue No. 100 on regenerative flame lamps giving specifications for direct-current multiple, alternating-current multiple and direct-current multiple series lamps; also circular on "Abolites" which are provided with a metallic reflector support with a positioning device by which the reflector can be properly set for various lengths of Mazda lamp bases.

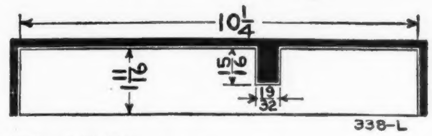
Westinghouse Electric & Mfg. Co., Pittsburg, Pa. Folder No. 4184 illustrating and describing the spider armature construction used by the company, its railway motor brush holders, armatures and axle bearings and unit switch control system, both for 600 and 1200 volts. The comparative advantages of interpole and non-interpole railway motors and all-box frame *vs.* split frame motors are discussed.

Crocker-Wheeler Co., Ampere, N. J. Booklet on induction motors illustrating and describing the Crocker-Wheeler magnetic bridge system of induction motor construction which increases the power factor without reducing the clearance of the rotor. Engineers concerned with electric motor installation will find the booklet of unusual interest and value, it being virtually a little treatise on the characteristics of open and closed slot induction motors.

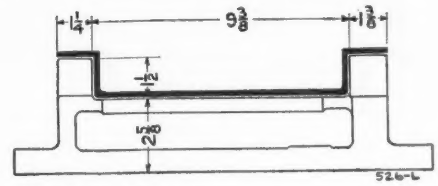
Hisey-Wolf Machine Co., Cincinnati, Ohio. Catalogue of Hisey portable electric machine tools, illustrated with views of the new plant and a large variety of styles of electric tools, comprising toolpost grinders for lathes and planers, bench grinders, pedestal grinders, wet tool grinders, aerial grinders, flexible shaft tools, electric hand or breast drills, screw feed electric drills, portable bench drills, electric Scotch radial drills, glass working tools, etc.

Some Examples of Work done on the

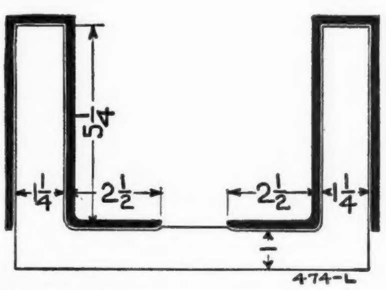
No. 4 Plain High Power Cincinnati Miller



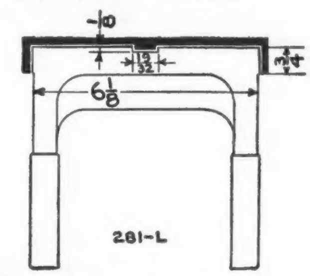
Material, cast iron.
Total width of cut, 13 5-8 inches.
Also one slot, 15-16 inch x 19-32 inch.
Depth of cut, 3-16 inch.
Length of each piece, 14 inches.
Cutters, 8 inch, 3 1-2 inch, 5 3-4 inch diameter.
36 R.P.M., feed 6 1-8 inches per minute.
Total metal removed per minute, 78 cubic inches.
Actual cutting time, 3 minutes per piece.



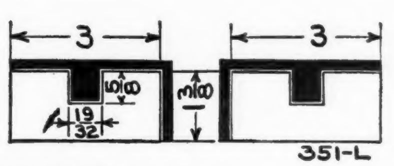
Material, cast iron.
Total width of cut, 15 inches.
Depth of cut, 3-16 inch.
Length of piece, 6 inches.
Largest cutter, 6 inch diameter, 9 3-8 inch face.
32 R.P.M., feed 4 3-4 inches per minute.
Metal removed per minute, 13 1-4 cubic inches.
Actual cutting time, 2 1-2 minutes.
Total time per piece, 4 1-4 minutes.



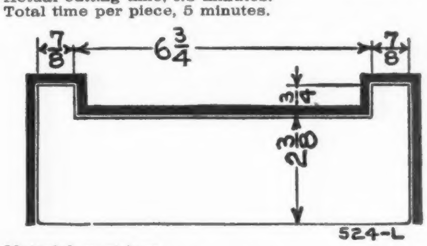
Material, cast iron.
Total width of cut, 23 inches.
Depth of cut, 1-8 inch.
Length of piece, 12 1-2 inches.
Largest cutters, 13 1-2 inch diameter.
14 R.P.M., 4 3-4 inch feed.
Metal removed per minute, 11 1-2 cubic inches.
Eight surfaces milled at one time
Final finishing cut brings them accurate within .001 inch.
Total time roughing, per piece, 6 minutes.
Actual cutting time, 3.3 minutes.



Material, cast iron.
Total width of cut, 7 5-8 inches.
Also tongue slot, 19-32 inch x 1-8 inch
Length of piece, 6 1-2 inches.
Depth of cut, maximum, 3-16 inch.
Largest cutters, 4 1-2 inch diameter.
45 R.P.M., feed, 7 inches per minute.
Height of work above table, 7 1-2 inches.
Metal removed per minute, 10 1-2 cubic inches.
Actual cutting time, 1.3 minutes.
Total time per piece, 5 minutes.



Material, cast iron.
Total width of cut, 8 3-4 inches.
Also two slots, 19-32 inch x 5-8 inch.
Depth of cut, 3-16 inch.
Length of piece, 25 inches.
Cutters, 8 1-4 inches, 4 1-4 inches, 3 inches in diameter.
36 R.P.M., 6 1-8 inch feed.
Metal removed per minute, 15 cubic inches.
Total time, including chucking per piece, 7 minutes.
Actual cutting time, per piece, 2.4 minutes.



Material, cast iron.
Total width of cut, 16 3-8 inches.
Depth of cut, maximum, 3-16 inch.
Length of each piece, 8 1-4 inches.
Largest cutter, 10 1-2 inches diameter.
21 R.P.M., 6.3 inch feed.
Metal removed per minute, 19 cubic inches.
Actual cutting time per piece, 1 3-4 minutes.

As compared with all others, our High Power Millers are—

Handier, because all the levers are within easy reach of the operator's usual position. The feed levers always indicate the direction of table travel; the indexes are truly direct-reading, and the treadle facilitates speed changing.

More rigid, because they are designed on the box section principle throughout.

More durable, because all driving gears are steel, and those most used for speed changing are nickel steel and hardened. All iron castings are now made in our own foundry and are of the highest quality.

The Cincinnati Milling Machine Co., Cincinnati, Ohio, U. S. A.

EUROPEAN AGENTS—Alfred H. Schutte, Cologne, Brussels, Milan, Paris and Barcelona. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague and Berlin. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. CANADA AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIA AGENTS—Thos. McPherson & Son, Melbourne. JAPAN AGENTS—Andrews & George, Yokohama. CUBA AGENT—Adolfo B. Horn, Havana. ARGENTINE AGENTS—Adolfo Mantels & Co., Buenos Ayres.

INGERSOLL-RAND Co., 11 Broadway, New York. Bulletin No. 3210 of twelve pages, describing class NE-1 power-driven single-stage straight-line air compressors. This compressor is of the type consisting of an air cylinder supported by a main frame with a piston, operated by a center crankshaft having the belt wheel on one side and the flywheel on the other. The shaft and wheels can be reversed in the bearings, if it is preferred to have the belt wheel on the opposite side.

BRISTOL Co., Waterbury, Conn. Condensed catalogue No. 160 on Bristol's recording instruments for pressure, temperature, electricity, time, etc. The usefulness of recording instruments has been enhanced by the improvements made in the past few years; the range of instruments now available covers practically every phase of engineering development. The catalogue should prove of value and interest to superintendents, general managers, engineers, and others concerned with the economical production and use of power, etc.

INGERSOLL-RAND Co., 11 Broadway, N. Y. Bulletin No. 3007 containing twenty-four pages of descriptive matter on class "PB" power-driven air compressors, duplex type with air cylinders close coupled to the frame, and a central driving wheel. The catalogue shows several views of machines and gives tables of sizes and capacities. The distinctive features of the design are massive, powerful construction, simplicity and reserve power. Automatic control of the air pressure and regulation of output to load are provided for by governing devices.

GENERAL ELECTRIC Co., Schenectady, N. Y. Bulletin No. 4878 on cloth pinions. This new form of machine element is offered for a wide variety of applications in power transmissions where, because of noise or for other reasons, metallic gears are impractical or undesirable. The advantages claimed for the cloth pinions are: great tooth strength, noiseless operation, freedom from damage by exposure to dampness, temperature changes, and vermin, elasticity of teeth, self-lubrication and long life. They are made in various styles and sizes some of which are illustrated.

INGERSOLL-RAND Co., 11 Broadway, New York. Form No. 3109 illustrating and describing class NF-1 steam-driven single-stage straight-line air compressors. These compressors are of the twin flywheel, center crank, enclosed type, with steam and air cylinders arranged in tandem. The catalogue shows several views of the machine in section and gives tables of cylinder diameters, capacities and dimensions. Air inlet valves on the smaller machines are of the "direct lift" type, and on the larger machines of the "hurricane inlet" type. "Cushioned direct lift" discharge valves are standard on all sizes.

GREEN FUEL ECONOMIZER Co., Matteawan, N. Y. Ninety-four page treatise on the hot blast system of heating and ventilating, containing valuable information for engineers and others concerned with the heating and ventilating of shops, mills, factories, etc. It contains data on temperature required in rooms for various purposes; heat transmission through building materials; heat given off by occupants and lights; standard sizes of hot blast heaters; loss of head by friction in air pipes; total weight of saturated air in pounds per cubic feet; humidities of different temperatures in the United States, etc.

DIAMOND CHAIN & MFG. Co., 240 W. Georgia St., Indianapolis, Ind. "Power Chains and Sprockets," a treatise by Lucius M. Wainwright, president of the company. The treatise is illustrated with views showing applications of chain transmission and the manufacture of chains in the Diamond Chain & Mfg. Co.'s plant. Guards for encasing transmission chain on automobiles and auto-trucks are of suggestive value to designers, as are also the many illustrations of chain transmission applications. The treatise concludes with a catalogue of the Diamond chains which are made in a great variety of sizes and styles.

WINDSOR MACHINE Co., Windsor, Vt. Catalogue and treatise on Gridley automatic multiple spindle, single spindle and semi-automatic turret machines. Few users of turret machinery know that the credit of being the birthplace of the first commercially successful turret machine belongs to Windsor, Vt. About sixty years ago, Mr. H. D. Stone and a few associates began the manufacture of turret machines in Windsor and they have been built there continuously ever since. The various types of Gridley automatics are illustrated and details of construction and principles of operation are fully described. Users of automatic machinery, and possible users, will find this work of much interest and value.

GARDNER MACHINE Co., Beloit, Wis. Folder entitled, "A Shop Sensation," illustrating the use of the Gardner disk grinder for finishing cast-iron box caps. These caps, weighing 23 pounds and having a surface area of 36 inches when made in the ordinary way, constitute a milling machine job, there being about 1/4-inch stock to remove. When the pattern is changed as recommended, the surface area to be machined is reduced to 17 square inches and the amount to be removed to about 1/64 inch. The milling machine proposition means ten finished pieces per hour; the grinding proposition, sixty pieces per hour: hence a large saving on the investment in the machines, as well as economy in cast iron and time is effected by the disk grinder.

ELECTRIC CONTROLLER & MFG. Co., Cleveland, Ohio. Bulletins, Numbers 1001, 1002, 1003, 1004, 1005, 1006, 1007, 1008, 1010, 1011, 1012, 1013, 1014, 1015 on type B limit switch; alternating current controllers; type Q brakes; type G controllers; type S crane switchboard; form H dynamic breaking Dinkey controllers; type E. C. & M. automatic float switch; type E. C. & M. automatic pressure regulator; type E. C. & M. automatic motor starter, form A; type E. C. & M. automatic motor starter, form AK; type E. C. & M. automatic motor starter, form AS; type E. C. & M. automatic motor starter, form ASK; type E. C. & M. automatic motor starter, form ASB; type E. C. & M. automatic starter, form ASBK, respectively.

GOULD & EBERHARDT, Newark, N. J. Handy pocket device for determining the revolutions per minute of carbon-steel and high-speed steel milling cutters cutting cast iron or steel. The device consists of a celluloid envelope with openings and a card carrying a table of cutter diameters, revolutions and speeds in feet per minute. The card, being pulled out of the envelope, shows cutter diameters and work speeds successively, through the openings, for cutters, from 2 to 7 1/2 inches diameter. The opposite side of the card carries a table of tooth parts, and openings in the envelope provide convenient means of determining the equivalent circular pitch, thickness on pitch line, addendum and total depth of teeth of diametral pitch gears.

UNION TWIST DRILL Co., Athol, Mass. Catalogue F or book of information on twist drills, gearing and milling cutters, containing 262 pages of data of value to machine shop managers, superintendents, foremen and machinists. An idea of the scope of the catalogue is given in the following partial list of subjects: Standard keyways, milling cutters, face mills, involute cutters for gears, formulas for gears, epicycloidal gear cutters, cutters for miter and bevel gears, sprocket wheel cutters, formulas for sprocket wheels, worm hobs, generating hobs, form cutters, convex and circular cornering cutters, reamer fluting cutters, end mills, metal slitting saws, screw slotting cutters, sharpening cutters, twist drills, grinding drills, table of cutting speeds, English-Metric conversion table, decimal equivalent of listed sizes, tap drill table, formulas for 29-degree and U. S. standard screw threads, wire tables, wire gage tables, weights and other useful data.

R. K. LEBLOND MACHINE TOOL Co., Cincinnati, Ohio. Catalogue of LeBlond lathes, comprising regular stud lathes, 14- to 20-inch swing, regular standard engine lathe 14- to 24-inch swing; regular quick change engine lathe 12- to 24-inch swing; heavy-duty manufacturers' automobile lathe, 17- to 21-inch swing; heavy-duty standard engine lathe 25- to 33-inch swing; heavy-duty quick change engine lathe, 25- to 33-inch swing; heavy-duty quick change sliding bed gap lathe 19-38- and 25-50-inch swing; regular plain chucking lathe, 14- to 24-inch swing; heavy-duty quick change combination turret lathe, 17- to 33-inch swing; heavy-duty quick change special turret lathe, 17- to 33-inch swing. The catalogue is handsomely illustrated and the description of features leaves little to be desired. The arrangement of matter and cuts is lengthways of the page, making a neat and attractive appearance. A feature for special accommodation is the elevation drawing of countershafts and plan of lathe with tabulation of dimensions. This data is indispensable for customers. It is a feature that all machine tool builders should incorporate in their catalogues.

TRADE NOTES

L. S. STARRETT Co., Athol, Mass., has issued a statement regarding the discontinuance of its use of the union label.

HUDSON EXPORT & IMPORT Co., 91-93 Wall St., New York, is now sole agent in the United States for the RBF ball bearings.

BUFFALO COPPER & BRASS ROLLING MILL Co., Buffalo, N. Y., has opened a New York office at 1216 Flatiron Bldg., in charge of Mr. James E. Barkley.

READY TOOL Co., Bridgeport, Conn., has purchased the business of the M. B. Hill Mfg. Co., Worcester, Mass., manufacturer of a line of milling machines and lathe dogs.

MUMFORD MOLDING MACHINE Co., Plainfield, N. J., has appointed Mr. James T. Lee, formerly of the Hanna Engineering Works, as its Chicago representative. Mr. Lee's address is 2059 Elston Ave., Chicago, Ill.

RUGGLES-COLES ENGINEERING Co., New York, general agent for the Bayonne Casting Co., Bayonne, N. J., has received an order from Pusey & Jones Co., Wilmington, Del., for two 66-inch propellers cast of monel metal for a large private yacht.

WIENER MACHINERY Co., 50 Church St., New York is the representative of Ernst Schiess, Ltd., of Düsseldorf, Germany. See another part of this number, engineering edition, for illustrated account of the activities of some Düsseldorf engineering concerns.

AMES PLOW Co., has built a new shop building at Framingham, Mass., and will remove its entire plant from Worcester to that place during December. The firm, first known as the Joel Nourse Co., which was founded in 1825, builds a large line of agricultural tools and machines.

WESTERN TOOL & MFG. Co., Springfield, Ohio, manufacturer of "Champion" tool-holders, expanding mandrels, "Challenge" hacksaws, shop furniture, etc., has built an addition to its shops which will be equipped with new tools for the manufacture of metallic machine shop furniture.

BROWN HOISTING MACHINERY Co., Cleveland, Ohio, has opened offices in Chicago and San Francisco. The Chicago office is in the Commercial National Bank Bldg., and Mr. A. M. Merryweather is the manager. The San Francisco office is in the Monadnock Bldg., and Mr. J. P. Case is the manager.

KELLY REAMER Co., 1555-1557 Columbus Road, Cleveland, Ohio, has recently opened offices in New York, Boston and London. The New York office is at 96 and 98 Reade St., the Boston office at 170 Oliver St., and the London office at 112 Queen Victoria St. The company reports an unusual demand for its product and indications of increasing business for the winter months.

MESTA MACHINE Co., Pittsburg, Pa., has received an order from the Sistersville Electric Light & Power Co., Sistersville, W. Va., for a 20-inch by 24-inch twin tandem, horizontal double-acting, four-cycle gas engine. The engine will operate with natural gas, and will drive direct a 650-kilowatt, 60-cycle, 2300-volt railway generator. The engine is rated at 1000 horsepower.

HESS-BRIGHT MFG. Co., Philadelphia, Pa., maker of ball bearings, announces that it has received word from the Deutsche Waffen und Munitionstabriken, for which the company is importer, that the DWF bearings have just been awarded the "Gran Premio" at the International Industrial and Trade Exhibition of Turin, this being the highest distinction.

PEERLESS GEAR TESTER MFG. Co., Cleveland, Ohio, was recently organized with a capital of $50,000, by Worthington Hoyt, L. H. Mesker, W. B. Hale, R. L. Matthews and A. W. Kilbourne, to manufacture a gear tester invented by R. L. Swartz. The tester gives a reading in thousandths of an inch, in the variation of the pitch diameter, concentricity and thickness of teeth in both bevel and spur gears.

MACHINERY has opened its own offices for circulation work and the sale of its reference books at 27 Chancery Lane, London, W. C., England, where files of this journal and a complete stock of reference books will be carried. The circulation work for Great Britain will be handled from the London office in future. Messrs. Wm. Dawson & Sons, Ltd., will continue to receive subscriptions through the book and news trade.

INTERNATIONAL MOTOR Co., 30 Church St., New York, is an organization recently formed for selling motor trucks and furnishing service to owners. It is incorporated under the Delaware laws and capitalized at $10,000,000. The manufacturing will be carried on at the Saurer motor truck plant at Plainfield, N. J., and the Mack Bros. plant at Allentown, Pa. A combined output of 2000 trucks from the two factories is planned for the coming fiscal year.

TITANIUM ALLOY MFG. Co., 1225 Oliver Bldg., Pittsburg, Pa., calls attention to statistics issued by the American Iron & Steel Association, 1911, in which it is shown that titanium is the greatest of all cleansers or deoxidizers for steel. The statistics show that the tonnage of steel treated with various alloys during 1910 was: Titanium steel, 326,316 gross tons; nickel steel, 106,707; nickel-chrome steel, 52,021; chrome steel, 23,550; manganese steel, 19,360; vanadium steel, 9049; other alloy steels, 30,816; total, 567,819 gross tons.

HETHERINGTON & BERNER, Indianapolis, Ind., have completed the shops of their new plant consisting of a strictly modern machine shop, gray iron foundry, structural steel and sheet-iron shop, power house, and office building. The structures provide 65,000 square feet of floor space. The entire property consists of about four acres and is provided with 1000 or more feet of switches. The company builds asphalt paving machinery, centrifugal pumps, tile presses, special machinery, and makes structural steel work, and foundry work.

OEKING Co., 50 Church St., New York, has been incorporated to sell punching and shearing machines manufactured by the Stahlwerk Oeking of Düsseldorf. A large stock of machines will soon be on hand for prompt deliveries in Jersey City, where spacious warehouse facilities have been provided. The management of the Oeking Co. is in the hands of the Wiener Machinery Co., which has made a specialty of importing similar machines. The German Oeking works employs about 1000 men and is said to be the only manufacturer that does not depend for its steel castings upon outside steel foundries. Its steel works has a capacity of about 15,000 tons annually of steel castings which are used in its machinery department.